This Number of the ELECTRICAL NEWS contains a full report of the Sixth Convention of the Canadian Electrical Association.

CANADIAN ELECTRICAL NEWS AND STEAM ENGINEERING JOURNAL

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JULY, 1896

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neighboring plants had to shut down & had transformers burned out. After having had an eight month run with this plant and knowing the trouble was in the wheels being clogged with blades, and having visited a large number of other plants to see the various system at work I have no hesitation in saying that our plant gives the steadiest light I have yet seen, runs the coolest, regulates the best uses less oile (less than one pint in Eights Months) is the easiest taking care of and requires less power for the number of lights than any other system that I have seen. Visitors from other towns remark the steadiness of and brilliancy of our lights and we have not replaced over twenty lamps out of the three hundred origenaly installed, Eight months ago: many central station operators have visited the plant and all express themselves being pleased with the S.K.C. Dynamo — admiring the symplicity of it its mechanical constructi and the ease with which it operates: any ordinary man capable of running machinery can be instructed fully in its operation in fifteen minutes, we have had no trouble with the Dynamo whatever or the transform. and I am satisfied the regulaton of the two phase syste is all right and that a more perfect piece of mechanism than the Dynamo furnished by you would be hard to produce: I feel it is in justice due to you to state these facts and that they may be given every publicity you have my permission to use this Letter as you see fit and I trust it will serve to completely contradict the incorrect stories which have been either maliciously or ignorantly circulated respecting this plant: wishing you every sucess I remain &c.

J. H. Davidson
Brighton
Ont

CANADIAN

ELECTRICAL NEWS

AND

STEAM ENGINEERING JOURNAL.

VOL. VI. JULY, 1896 No. 7.

CANADIAN ELECTRICAL ASSOCIATION

PROCEEDINGS OF SIXTH ANNUAL CONVENTION.

THE Sixth Annual Convention of the above Association was opened in the Council Chamber of the Board of Trade Building, corner of Yonge and Front streets, Toronto, on Wednesday, the 17th June, 1896, at 2:30 o'clock, p.m.

Mr. A. B. Smith, the President, presided.

The following persons were in attendance :

K. J. Dunstan,	*Toronto, Ont.*	*A. Knowles,*	*Toronto, Ont.*
J. A. Kammerer,	"	Irving Smith,	"
John C. Gardiner,	"	E. K. M. Wedd,	"
J. J. Wright,	"	W. A. Johnson,	"
J. Norman Smith,	"	J. K. Johnston,	"
F. C. Armstrong,	"	James Milne,	"
A. E. Payne,	"	T. F. Dryden,	"
Wm. Bourne,	"	P. G. Gossler,	Montreal, Que.
James Orr,	"	Fred. Thomson,	"
J. F. H. Wyse,	"	John Carroll,	"
George White-Fraser,	"	James A. Baylis,	"
J. W. Campbell,	"	H. R. Leyden,	"
Ed. D. McCormack,	"	J. Rogers,	London, Ont.
J. J. Ashworth,	"	Charles B. Hunt,	"
A. M. Wickens,	"	John Yule,	Guelph, Ont.
A. A. Christie,	"	Wm. Williams,	Sarnia, Ont.
George F. Madden,	"	W. B.W. Armstrong,	Parry Sound.
T. W. W. Hilliard,	"	George Black,	Hamilton, Ont.
F. C. Robertson,	"	B. J. Throop,	"
C. P. Dwight,	"	M. W. Hopkins,	"
H. P. Dwight,	"	E. Carl Breithaupt,	Berlin, Ont.
E. B. Biggar,	"	J. W. Howry,	Fenelon Falls, Ont.
F. B. Moore,	"	E. E. Cary,	St. Catharines, Ont.
Joseph Wright,	"	G. A. Powell,	"
J. S. Robertson,	"	W. G. Bradley,	Ottawa, Ont.
T. R. Rosebrugh,	"	D. Elliott,	"
Alex. Stark,	"	S. Rose,	"
W. J. Clarke,	"	A. A. Dion,	"
F. C. Maw,	"	D H. Keeley,	"
W. R. Evans,	"	J. W. Taylor,	"
A. B. Smith,	"	O. Higman,	"
C. H. Mortimer,	"	C. S. Mallett,	Peterboro', Ont.
F. J. Ricarde Seaver,	"	John C. Grant,	"

The President called the convention to order and stated that the first thing on the programme was the President's address, which he assured the members would be very short. He then addressed the convention as follows :

PRESIDENT'S ADDRESS.

GENTLEMEN OF THE CANADIAN ELECTRICAL ASSOCIATION :

It is with great pleasure that I meet the members of this Association at the present convention.

It is rather unfortunate that we were compelled by force of circumstances to hold our convention about the time the country is engaged in a political contest. This has undoubtedly prevented the attendance of some of our most valued members, but I hope, nevertheless, that our meetings will be as interesting and enjoyable as on any former occasions.

The papers to be presented promise to be of great interest in connection with subjects of the utmost importance to the electrical fraternity.

We are particularly fortunate in our place of meeting, and are indebted to the officers of the Toronto Board of Trade for the privilege of our pleasant surroundings.

As but a comparatively short time has elapsed since our last meeting, there is not much of actual achievement to chronicle, but there have been developments in the electrical field that indicate the possibilities of a revolution in our method of producing light by electricity. Many minds have for some time past been occupied with explorations in this promising direction. The production of light without heat has a fascination for the inventor that will probably lead to tangible results in the very near future. *The ordinary developments of the science as exemplified in modern systems of power transmission,* and electrical construction generally, have advanced towards perfection in as great a degree as in former years, but the field for the enterprising inventor, so far from being exhausted, appears to be growing broader and ever broader with unlimited possibilities.

Notwithstanding the commercial depression, electrical industries in Canada may be said to be in a flourishing condition. The larger electrical manufactories are in full operation, and report a large increase in the output, and with many contracts on hand. It is likely that during the coming year their capacity will be considerably increased. The wonderful increase in the use of electricity for all purposes necessitates the installation of larger units. Dynamos that were considered colossal a few years ago are now being abandoned on account of their lack of capacity. This is leading to the equipment of the factories with more modern and powerful machinery for their production. The allied trades of the tool builder, machinist and engineer are all therefore receiving the benefit of this *development of the electrical age.*

Not the least of the current developments is the remarkable increase in the number and mileage of electric railways. The electric motor, a short time ago considered as limited to urban and suburban work, is now usurping the functions of the steam locomotive, and it is not too much to say that ere long we may expect to see it on our main lines of railway.

In other branches of electrical work good general progress has been made in perfecting systems and methods at present in use, both electrically and mechanically. The telegraph, with its adoption of new and rapid self-recording apparatus, and the telephone, with its improvements in long distance transmission of speech, are fully keeping pace with improvements in other departments.

The Association is to be congratulated on the promising outlook. It is likely that in the immediate future, with an improvement in the financial world, and as disturbing elements are eliminated, the developments will be even more rapid than in the past, and an era of greater prosperity than ever will be abundantly realized.

The President's address was greeted with applause.

The Secretary read the minutes of the fifth annual convention, which were confirmed.

The Secretary also read the Secretary-Treasurer's report as follows :

SECRETARY-TREASURER'S REPORT.

During the year covered by this report, the Association has made satisfactory progress. During the Association year beginning 1st June, 1895, and closing 31st May, 1896, there were added to the membership roll 24 active members and 4 associate members. During the same period 8 active and 7 associate members tendered their resignations, leaving the net gain in membership, 13.

Since the close of the Association year, there has been elected 21 active members, making the present membership 194 active members and 35 associates, a total of 227.

There are on the roll a considerable number of persons who, without having resigned their membership in the Association, have ceased to take an active interest in its affairs, and have likewise failed to pay their membership fees. It should be understood that when a person joins the Association, he thereby becomes a member, not for one year only, but until such time as he formally resigns his membership, and that until his formal resignation is received by the secretary and accepted by the Executive Committee, he continues to be liable for payment of the annual fee. It is perhaps due to the lack of a definite understanding on this point that the actual standing of the Association, with regard to its bona fide membership, is at the present time somewhat uncertain. The time has arrived when definite action should be taken to put an end to present and future uncertainty with regard to this matter.

It was to be expected that some of those, who at the outset became members of the organization, without being actually interested in the work which it is designed to accomplish on behalf of the electrical interests, would soon drop out. In the place of such, the Association has within the past two years been receiving as members, persons connected with the various departments of electrical work, and who therefore *feel the benefit to be derived from connection with the organization* and have a personal interest in its welfare. It thus appears that, while for a time, the additions to the membership may be in a measure offset by the withdrawal of members of the first mentioned class, the Association is steadily gaining in character and influence.

The annual conventions, which have been extremely interesting and enjoyable from the commencement, are becoming more so year by year, in proof of which I need only point your recollection back to the delightful meeting in Ottawa last autumn, and direct your attention to the character of the programme on this occasion. Two meetings of the Executive Committee have been held since the close of the Ottawa convention, viz.: on the 22nd of October, 1895, and the 16th of January, 1896. At the first of these meetings, accounts in connection with the Ottawa meeting were examined and ordered to be paid, and the secretary instructed to have printed 500 copies of the revised constitution. At the second meeting two active members were elected. Messrs. Wright, Breithaupt and the president were appointed a committee to endeavor to make arrangements for a popular scientific evening lecture in connection with the present convention. The selection of a suitable place of meeting for the convention was left in the hands of the Toronto members of the Executive. The secretary was instructed to make request of the following persons for papers on the subjects named: Mr. O. Higman, Ottawa, "Lamp Tests"; Mr. P. G. Gossler, Montreal, "High Potential Underground"; Mr. J. M. Campbell, Kingston, "Long Distance Power Transmission", Mr. Charles P. Dwight, Toronto, "Ocean Cables", Mr. F. C. Armstrong, Toronto, "The Future of the Electric Railway"; Mr. James Milne, Toronto, "Meters"; W. McLea Wallbank, Montreal, "Utilization of the Power of the Lachine Rapids", Mr. George Black, Hamilton, "Acetylene Gas", C. F. Medbury, Ottawa, T. R. Rosebrugh, George White Fraser and E. J. Philip, Toronto, subjects not named. Mr J. J. Wright was appointed a committee to ascertain whether a suitable steamer could be chartered for an excursion and dinner in connection with the annual convention. The sum of $25.00 was placed at the disposal of the Committeee on Statistics. The Toronto members of the Executive were appointed a committee to perfect local arrangements for the convention.

Following is a statement of the receipts and disbursements for the year:

FINANCIAL REPORT FROM 1ST JUNE, 1895, TO MAY 31ST, 1896.

RECEIPTS.

Cash in bank June 1, 1895		$186 77	
Cash on hand June 1st, 1895			
93 active members fees at $3.00		279 00	
14 associates at $2.00		28 00	
Refund by Statistical Committee		23 62	
			$517 39

DISBURSEMENTS.

Expenses of convention at Ottawa		$218 92	
By cash as per local committee statement	$100 00		
" caretaker at Ottawa	3 00		
" express charges on books to and from Ottawa	1 40		
Canadian Electrical News, printing	72 50		
" Canadian Photo-Engraving Co.	16 22		
" A. F. Sladen, stenographer	25 80		
	$218 92		
Electrical News for printing		7 00	
Postage		35 10	
Exchange on cheques		1 50	
Blackhall & Co., 50 leather certificate covers		4 00	
Grant to secretary		50 00	
Mortimer & Co., badges, including protest charges		17 16	
Grant to Statistical Committee		25 00	
		$358 68	
Cash in bank, May 31st, 1896		157 21	
Cash on hand, May 31st, 1896		1 50	
			$517 39

RECEIPTS SINCE MAY 31ST, 1896.

June 1st, 1896, cash on hand	$ 1 50	
38 active members' fees at $3.00	114 00	
1 active member's fee at $5.00	5 00	
3 associate members' fees at $2.00	6 00	
Cash for exchange on cheque	15	
		$126 65

EXPENDITURES.

Ribbon and pins for badges	$ 2 88	
Receipt forms	40	
Postage	20 78	
Exchange on cheques	1 15	
Envelopes	15	
	$25 36	
Cash deposited in bank since June 1st, 1896	95 15	
Cash on hand June 17th, 1896	6 14	
		$126 65

Total standing to credit of Association, June 16, $258 50.

Certified correct,

B. J. THROOP } Auditors.
A. A. DION }

On motion of Mr Dunstan, seconded by Mr Kammerer, the report was confirmed and adopted.

The President. The next thing will be the reception of reports from committees. Mr. J. J. Wright will report for the Committee on Legislation and Mr. E. C. Breithaupt for the Committee on Statistics.

Mr. Wright. There not having been any legislation either in the Dominion or Local Houses that would affect electrical interests in any way, the Committee on Legislation have no formal report to make.

Mr. E. C. Breithaupt read the report of the Committee on Statistics, as follows:

REPORT OF THE COMMITTEE ON STATISTICS.

Your committee beg to report as follows. - The committee endeavored during this year to carry into effect the idea expressed in the report of last year's statistical committee as to the compilation of data relating to central stations for the supply of electric light and power. To this end we drew up a blank form, requesting information on the following points, namely, motive power, station apparatus, station output, running time of station, and prices obtained. Information regarding the original cost of installation and cost of operation was not asked for, because it was deemed advisable not to make the form too long and complicated, but it was thought that if a proper interest were shown by central station men in the compilation of these statistics, they might at a later date be filled out more completely. There is no doubt that complete statistics of the central stations for the supply of electric current throughout the Dominion would be a reference book of no small value to all persons connected with the industry, and the committee have given considerable thought as to how this idea could be best put into practice. It has been thought that the formation of a sort of bureau of statistics, kept in the archives of the Association, to which any active member could have access, would best serve the end in view. The committee recognize that there is considerable information concerning the operation of a plant which proprietors cannot afford to have made public; the more general data, such as first cost of plant and particulars concerning the plant and apparatus, could be kept on file in the secretary's office and revised annually, so that any member of the Association could, on application to the secretary, obtain whatever general information he might want for his private use. Particular data should of course in each case be obtained personally, and it is fair to assume that between members of the Association, where the person requesting information and the object are known, it would be cheerfully given. The committee are of the opinion that a scheme for the compilation of statistics somewhat in the nature of a bureau of mutual information, as above outlined, would be a valuable adjunct to the work of the Association, and respectfully recommend its consideration.

Of the blanks sent out only a comparatively small proportion were returned, and in some instances were not filled out so completely as they should have been. However, the returns received would form a fair basis on which to continue the work. Because of the incompleteness of the returns the committee have not considered it advisable to draw up a tabulated summary.

The statistics received bring to light some interesting facts. Of the total number of replies received only three are from municipal plants; 12 companies only state that they supply current for power purposes, and two only supply current for heating; one for electric welding.

One fact which is particularly prominent is that the majority of the smaller stations are operated only during a very short period every 24 hours, mostly from dusk till midnight. In most of these cases it is probable that a sufficiently large motor load could not be obtained to employ the station during the day-time.

The committee do not consider that the work which they have done is in any way finished, and strongly recommend that it be continued during the coming year.

All of which is respectfully submitted.

E. CARL BREITHAUPT, Chairman.

On motion of Mr. F. C. Armstrong, seconded by Mr. J. J. Wright, the report was received and allowed to stand until Thursday, the 18th June, for consideration.

GENERAL BUSINESS.

The President read a telegram from Mr. L. B MacFarlane, 2nd Vice-President, as follows:—"I sincerely regret that I cannot attend convention. Hope meeting will eclipse all former ones"; and stated that he was sure that all the members of the Association present would regret Mr. MacFarlane's inability to be present.

The President called the attention of the members to the banquet to be held at Lorne Park on the following evening, and requested them to inform the Secretary as soon as possible of their intention to be present. He also urged on the members to be present with their friends at the lecture on "Radiant Matter" to be given by Mr. James Milne in the rotunda of the Board of Trade building in the evening, as it would be an encouragement to Mr. Milne and the officers of the Association.

The President: While I am on my feet, and before proceeding with the consideration of the first paper to be read, I desire to say that it is quite gratifying to the Executive of the Association that so many new members are coming in, especially central station men. There were twenty-three new members elected, and I think about twenty of them are central station men. That of itself is very gratifying, and shows that the Association is fulfilling its mission. I hope to see more of them.

The first paper on our list is "Ocean Cables," by Mr.

C. P. Dwight, of Toronto. I am very sorry we will have to dispense with this paper. Mr. Dwight made an earnest effort to have it ready, but he found that the data necessary to give us an authentic, clear and concise history of ocean cables was so obscure, and required so much digging out, that he has not been able to complete it. I hope at some future time we will be favored with it--perhaps at the next convention.

We will pass on now to the paper on "Acetylene Gas," by Mr. George Black, of Hamilton. (See page 141).

Mr. Black, on rising to read his paper, said: Mr. Chairman, in coming away in a hurry I forgot two things. I forgot my paper (although I find it printed here), and I forgot some matches; so, if the gentlemen here have a supply of matches on hand I hope they will take up a collection in the meantime.

After the reading of the paper, Mr. Black gave a demonstration of the light produced from acetylene gas by means of a small apparatus which he had improvised for the purpose, and which he explained the working of to the members present. He stated that they were, in this demonstration, competing with the sunlight, and it was hardly a fair test.

Mr. J. J. Wright: I would like to know the pressure you have on.

Mr. Wickens: I think the pressure is less than half a pound.

Mr. Black: This gives the yellow flame because it does not oxidize sufficiently. I may say in the course of the next two or three weeks Mr. Willson's factory will be in full blast, and I understand he is going to light up St. Catharines. Several establishments will have the gas pure to show the results, so that all who are interested can visit St. Catharines to see it for themselves.

Mr. F. Thomson: Is there any place where they are actually using this gas?

Mr. Black: Not as yet.

Mr. Thomson: They have been making it for the last couple of years back.

Mr. Black: Just experimenting. A number of factories have been watching to see the result of the Niagara Falls output before they start.

Mr. Thomson: They have been manufacturing since May.

Mr. Black: Since May.

Mr. Thomson: Some of that ought to be used.

Mr. Black: It requires a good deal to make a contract with a town, and you have to have a good supply to keep it up, and not run out of it.

(At this point the electric light in the room was turned on, and comparisons made with the acetylene gas.)

Mr. Wickens: The globes on the electric light kill forty per cent. of the light, whereas the acetylene gas is a bare light.

Mr. Black: I have had it without the slightest trace of yellow color, and with just a blue spot about the size of a pinhead.

Mr. Wright: I understand that Mr. Black informs us that Mr. Willson proposes to use that gas in St. Catharines as a mixture or energizer to the ordinary gas. In the paper I notice that he says that it does not mix very well with the water gas; in fact, it is no use for that; it will mix better with coal gas. We all of us know, I think, that there is precious little coal gas manufactured. Very nearly all the gas companies are running with water gas. If that is really the case there does not appear to be very much field for this product as an energizer for the ordinary gas of commerce, as we may call it. The gas companies, for the sake of using it, save as an energizer, would never exchange their water gas plants and go back to the old methods of producing coal gas at a vastly greater expense in order to use acetylene gas, which is manufactured at a tremendously low rate. My remarks are with reference to gas plants all over the country. We are all aware that the largest gas plants are water gas plants.

Mr. Black: I don't know anything about the condition of the gas companies. In Hamilton I know it is coal gas which they make. I understand in Toronto it is water gas.

Mr. Wright. Both.

Mr. Johnson. Is there any difference in using iron, brass or copper tubing? Does it cause any trouble by using the brass or copper?

Mr. C. S. Mallett: I believe it combines with copper and makes a kind of deterioration; it uses up the copper, I understand. It also does with brass, but not to such an extent as to interfere with any fixtures like those (refers to fixtures used by Mr. Black in illustrating the acetylene gas.) On iron or lead it has no effect.

Mr. J. J. Wright: If there is a deteriorating effect and the copper would combine with the gas, that would certainly seem to rule out the fixtures at present in use. You could not guarantee that any brass fixture has not got a large proportion of copper in its composition. It appears that if this gas were used even as an enricher for ordinary gas, and used in an ordinary fixture, that the whole thing would have to be revised, new fixtures would have to be put in all over. Would not that have a tendency to shut it out as an energizer of ordinary gas?

Mr. Black: Have not all fixtures an iron pipe inside, for gas? I think the conducting pipe is iron.

Mr. Wright: Any number of gas fixtures are made of copper and brass piping.

Mr. Black: The parties who are running it do not think they will have any trouble.

Mr. Wright: They are rather too optimistic as to the outcome of this product. We are well aware that the true test of the merit of any new discovery is its use. It is two years now since Mr. Willson first discovered this gas; and we do not find that it is in use in any commercial or practicable sense. They have been making preparations in various places to experiment with it and that is about all. If this had been such a valuable energizer, as the making of it is such a very simple process, it certainly would have come into use to a very much greater extent than it has. I think you can look upon that as the true test of any new discovery.

Mr. Black: Anyone who makes such a discovery as this wishes to secure it as safely as possible before giving it out to the public. It takes a lot of capital to work a thing of that kind; it takes time to interest capitalists; it had to be tested in every possible way; they had to be satisfied by chemists and others that it was all right before they put their money in it. I have no doubt but that within the next six months you will see plenty of it.

Mr. Mallett: Why is it those three jets have lost a great deal of their illuminating power?

Mr. Black: We have stopped the generation of the gas and the pressure is taking care of itself. We might as well turn it out, but we wish to burn up the gas. Where you see the yellow flame it shows an excess of carbon.

Mr. Breithaupt: The paper we have listened to by Mr. Black is certainly one of great interest to all the members of the Association, and I think we should congratulate Mr. Black upon presenting the subject in such a concise and clear manner. The question of acetylene gas is one which is creating a great deal of interest throughout the country at the present time. I may say I have studied it up a little myself, and have data of tests that were made by two engineers of the Acetylene Gas Co., in Philadelphia, the company which is there exploiting this matter principally, I believe. These tests were made in North Carolina, before the three experts, Professor Houston, Dr. Kennelly and Dr. Kinnicutt made their tests, and they were not so favorable as the tests made by the three experts in March last. Of course we may expect in that time (it was nearly a year before that the other test was made) there was some improvement made. The cost of acetylene gas varies directly at the cost of producing the calcium carbide. The figures here given as to the cost of calcium carbide I think are altogether too optimistic. In the report of the test made by Professor Houston and Drs. Kennelly and Kinnicutt the cost of power is given as $5 per h.p. We all know that $5 per h.p. per annum is a figure that nobody ever dreams of, much less realizes. I am surprised that the rate mentioned has been secured at St. Catharines. Of course, if that is so the argument drops.

Mr. Black: About 200,000 h.p. is available in the province of Quebec at the same price.

Mr. Breithaupt: It is a price that is surprising, because nobody who has been in the business at all has known any such price. At Niagara Falls, where they are producing power in such enormous quantities, they are selling it at $20 per h.p. delivered at the works only. Therefore, one argument that is made throughout, that the production of calcium carbide can be utilized as an additional load to the ordinary small station, drops. The ordinary small station cannot deliver power at anything approximating $20 per h. p. For instance, here in Toronto or elsewhere where power has to be generated, from steam, the difficulties of using this gas as a pure illuminator would be great. Could this gas be controlled and distributed through pipes, if it were generated in a private house and be burned there just as it is generated? The Acetylene Company in Philadelphia were exploiting a system of generating directly in the place where it is to be used. They have for that purpose a generator similar in principle to what Mr. Black has here, just a box in which they keep the calcium carbide; they apply water to it and the gas goes from the generator directly into the house pipes. The great question is, how to regulate the pressure. The affinity that this compound shows for water is very great. I understand that once you have turned on a certain amount of water you cannot stop generation of the gas until that stock of water is completely exhausted. I was speaking to engineers in Philadelphia about it and I asked them how they regulated it. They said the only way is to let the gas escape, or else the pressure will get to such a height as to be dangerous.

Mr. Black: They have a safety valve, and if the pressure rises above a certain point it blows off.

Mr. Breithaupt: That would be wasted energy. As to the use of acetylene as an enricher for coal and water gas, I read a paper by Prof. Lewes on that point, and he said the gas does not mix properly with the water gas and is of very little value there. It is, however, a good enricher for coal gas. The commercial value of acetylene gas, taking all these points into consideration, *it seems to me is not quite so promising as its promoters* claim for it. There is another point to which Mr. Yule has called my attention with reference to laying pipes to distribute acetylene gas from a central station. At present, in laying distributing pipes for gas, we put the pipes below the frost line, not only to prevent condensation, but also to keep our pipes intact. If you lay pipes above the frost line the frost will soon break them. You must take into consideration that however you place these pipes, you have got to put them below the frost line in order to keep them intact, and then you would have just as much cost in laying as in laying ordinary gas pipes.

Mr. A. A. Dion: I have listened to Mr. Black's paper with a great deal of interest. It is a very good paper. But, I must say I am still in the same position that I was before; I am not yet able to make up my mind as to the true cost of acetylene gas, or its true value. I have read nearly everything that has been published in the technical journals concerning acetylene gas in recent years; and I have read with a great deal of attention, trying to form an opinion as to the real cost of producing the calcium carbide and also the true value of the gas as a possible competitor with electric lighting, but I found those articles so contradictory that it was impossible for me to form any opinion whatever, and I am still in the same position. I think, however, that Mr. Black's views of the prospects of acetylene gas are much too rosy. However, those of us who might have formed the opinion, as I had, that the gas was very poisonous, are consoled with Mr. Black's statement that it is not so poisonous as coal gas. I think it might be very much less poisonous than coal gas and still be very objectionable to most of us in that respect. Another thing: he argues that its strong pungent smell is a safeguard, and a person could not go to sleep before noticing it. We know that the ordinary illuminating gas has a very strong pungent smell, nevertheless accidents do happen. There is the further objection, that there is nothing necessarily alarming about the smell of garlic. There is one thing I wish to call your attention to, which is, I think, perhaps a misprint; Mr. Black states in his paper that the pipes can be laid below the surface for little or no expense. I cannot conceive of a case where no expense would be incurred.

Mr. Wickens: There is one matter that Mr. Briethaupt spoke of which was demonstrated here, while we were experimenting with the gas. The gas generates very quickly, as soon as the water strikes it; it is absolutely necessary to hold the meter down pretty well; it lifted it right up. It is hard to tell how to accommodate the pressure. It is evident it would be very troublesome to regulate the speed at which this gas is to be generated and delivered into a tank. You noticed that if we increased the pressure on the gasometer the light would flare up. As long as the pressure was at the same fixed point the light was steady, and as soon as we put a little extra pressure on it made the light considerably stronger. It is evident it is going to be very difficult, if it ever is accomplished, to exactly regulate the pressure, from the fact that the gas generates very rapidly and you could not tell when it is going to stop. After the color disappeared in the jar it was still making gas—it was still pushing against the counterweight.

Mr. Yule: I do not see any difficulty in overcoming the objections that Mr. Breithaupt makes. Supposing you have a fifty pound holder in your cellar, you will know how many pounds you can make from so many pounds of acetylene—making your gas in the afternoon before you start—and you simply use up your holder. Your pressure will be the same throughout the evening if your holder is of sufficient capacity to supply you with gas during that night. It is not necessary to make more gas while you are using it. So many pounds of acetylene will make so many feet of gas; it is simply the operation of leaving it stand there and using it in the night.

Mr. J. F. H. Wyse: Wouldn't that of itself be an objection to having the gas in the house if you had to *depend on the domestic to make the gas in that way?* It seems to me to be a serious objection. The master of the house would not want to have to look after a matter of that kind.

Mr. Wickens: Suppose we make a gas receiver or receptacle in that house. We know if we have so much water we are going to make so many feet of gas; the receiver will be of some fixed size and the pressure so much per square inch; we start our lights around the house, and if we use two-thirds of the gas generated we have made the receiver no smaller and the pressure has gone down.

Mr. Hopkins: I don't think that is so at all. That would not necessarily follow.

Mr. Armstrong: It is the running and regulating of the geneartor of acetylene from calcium carbide in what we might call the small unit which Mr. Willson seems to favor, but the difficulty would seem to be that it is not something that the ordinary domestic could be expected to handle in a satisfactory way. The possibility of danger and the difficulties are certainly greater than with the ordinary furnace, and they are generally found sufficient; and it seems to me unlikely, accustomed as people are now-a-days to depend on the central station or gas plants, that they would be disposed to have any bother. One thing which seems to have been left out of consideration is the fact that the calcium carbide for shipment must be put up in closely sealed packages, and when these are opened, on exposure to the air, it deteriorates very rapidly. Mr. Willson did not seem to favor the idea of distribution when liquefied under pressure in cylinders; he did not state for what reason, but I fancy it is on account of the danger of explosion when under high pressure, which I believe is very great. There is another point in connection with the gas which I think should not be overlooked, and that is, when the temperature is raised to about 300 degrees it becomes highly explosive, and in case of general use and in the case of fires that would become a very serious drawback to its use. It seems unnecessary to say anything about the estimates of cost which have been given. I think as yet they are not based on any ordinary commercial values, which we would require to have established before it could have any extended use. There is one small item which I see is entirely omitted in the calculation of the cost as given by Mr. Black, and that is the cost of the carbon electrodes, which is found to be a very considerable factor, and one that has been entirely overlooked.

Mr. Black: In reply to what Mr. Briethaupt said about regulating the pressure, and the Philadelphia engineers saying that they had to let the gas go to control it, I might say I have seen illustrations of a gas holder so arranged that as the gas goes up it shuts off the water; and as it is consumed and as the gas drops down it lets the water in, and by that means the manufacture of the gas is automatic. I think means will be found in practice to prevent the necessity of blowing off the gas when the pressure gets too strong. I noted here something about an error in figures, but I do not remember what it was.

The Pres. lent: It was in reference to the laying of the pipes.

Mr. Black: Those two little words, "or no," had better be taken out; there must be some expense in laying the pipes. The cost of the carbide has been variously estimated; some have made it as high as $100 a ton. Mr. Ferguson, who read a paper before the National Electric Light Association, figured it out, and I discovered an error in his figures of $7—reducing his figures by $7. I have not the paper with me. He was figuring on ten tons a day production, and he reduced the cost of labor, and so on. The price of the carbon electrodes he places at $7.77 for each ton more than the lime and the coke. That should be reduced by one-tenth, making the cost per ton 77 cents. I included the cost of the carbons in the other charges. As to the poisonous nature of the gas, one of the authorities who experimented declared it was only one-seventh as poisonous as ordinary gas. I won't vouch for that, but that is his statement. He is a Frenchman, and claims to be a scientific man. I think I have covered all the points, as far as I know. Had the convention been a few weeks later I would have had more perfect apparatus. Mr. Willson offered to send me one of the smallest household arrangements that he was making, but it was not yet completed, so that I had to come away without it. I left this until the last moment, expecting to have a more complete outfit. In the course of a few weeks we will have it before the public, and then the exact price can be got at.

Mr. Breithaupt: In answer to what Mr. Black has said, I wish to call attention to the fact, not that the water could not be shut off, but that the gas does not stop generating the moment the water is shut off, because the calcium carbide has to absorb all the water that is in the jar before it stops generating, and in that way the danger arises from generating with a small plant. I said that in Philadelphia they did not have any arrangement to relieve the pressure. I have much pleasure in proposing a hearty vote of thanks to Mr. Black for the paper he has given us. I am sure that it has been of great interest to the Association and of great benefit.

Mr. J. J. Wright: I think it is only fair to give it due credit. I think Mr. Black states in his paper that it is intoxicating; that certainly is a point that ought to be in its favor. I would like to trouble Mr. Black with one more question; that is, where is that 200,000 horse-power in the Province of Quebec?

Mr. Black: In the backwoods somewhere.

The President: It has been moved by Mr. Breithaupt, seconded by Mr. Wright, that a hearty and sincere vote of thanks be tendered to Mr. Black for his care in the preparation of this paper. (Carried with applause.)

The President: Mr. Black, I have great pleasure in conveying to you the thanks of this Association for the trouble and care you have taken in the preparation of this paper.

Mr. K. J. Dunstan: I may mention a little incident: A good many years ago we had trouble in Hamilton with a certain telephone line; we could not find the interruption. After a while a youngster was found hiding behind the fence tapping the line with a home-made telephone. Nothing much was done to the youngster, but the telephone was confiscated. The youngster was Mr. Willson.

Mr. Black: I think I have that telephone yet.

The President: Is it your wish to adjourn, or shall we proceed.

Mr. J. J. Wright: I move that the convention adjourn.

At 4:30 p.m. the convention adjourned to Thursday, June 18th, at 10 o'clock a.m.

ILLUSTRATED LECTURE BY MR. JAMES MILNE.

In the evening the Rotunda of the Board of Trade was filled with ladies and gentlemen assembled to hear Mr. James Milne's lecture on "Radiant Matter." The lecture was illustrated by numerous diagrams projected upon a screen, and with demonstrations of Roentgen rays, and was received with much interest and appreciation by the audience.

Immediately following the lecture a visit of inspection was made to the power stations of the Toronto Electric Light Co. and the Toronto Railway Co.

SECOND DAY.

MORNING SESSION.

The President called the convention to order at 10 a.m., and announced as the first order of business for the day the consideration of a place for the holding of the next convention.

Mr. J. Carroll: Mr. Chairman, I have pleasure in suggesting Niagara.

Mr. Breithaupt: I second that.

Mr. J. J. Wright: As I understand, there is no strong representation of the Association at Niagara Falls. That of course means that if we held a convention there we should have to carry our supplies along and make arrangements for the features of entertainment and so on independent of the place itself. I am not mentioning this because I have any objection whatever to Niagara Falls, but it is simply a matter that should be understood.

The President: That is a very important feature. We have no representative here from Niagara Falls. I presume when Mr. Carroll suggested Niagara he meant Niagara Falls.

Mr. Carroll: Yes.

Mr. Kammerer: While we have no representative at Niagara Falls except one, all that know that one will say he is a host in himself that is, Mr. Ross Mackenzie. I think the social features, and the taking care of the people when they get there, can be safely left in Mr. Mackenzie's hands.

The President: Allow me to read a letter which was received some time ago in connection with the coming convention:

NIAGARA FALLS PARK & RIVER RAILWAY CO.,

May 13th, 1896.

A. B. SMITH, ESQ.,
G. N. W. Telegraph Co., Toronto.

Dear Sir,—In connection with the coming convention of the Canadian Electrical Society, I beg to offer you on behalf of the company the freedom of the road for your members if you hold the convention at the Falls. We desire you to visit the Falls, and we trust that we may have the pleasure of your company.

Yours truly,
ROSS MACKENZIE, Manager.

We acknowledged the receipt of that letter and thanked Mr. Mackenzie very kindly for his invitation, and at the same time said that it was probable that at some future time we would hold our convention at Niagara Falls, and we would avail ourselves of his kindness. Are there any other places suggested?

Mr. J. J. Wright: It appears to me the only other place available would be Quebec. There was some talk of that last year. There would be a certain amount of objection to that on account of its distance from this end of the country. Having held the meeting in Ottawa last year, it practically leaves us with Toronto and Montreal, and having held conventions in these places in the not very remote past, we are left almost without any choice but Niagara Falls. It is a fine place to spend a few days, and we should have a very pleasant convention there.

The President: It is desirable from the Association's standpoint that our conventions should not be held exclusively in one section of the country. Objection may be taken to having a convention held in Niagara Falls succeeding the one held in Toronto, but if there are no invitations to go anywhere else, we have no alternative but to accept and decide on Niagara Falls, and I presume it is decided that we go there. With reference to the time, I think it should be in the month of June.

Mr. Kammerer: I think that is about the right time. We have a good sample of June weather here and a good sample of the crop that June brings, and it would bring just as good a crop at Niagara Falls. There will be no politics at this time next year.

The President: It is for this convention to say whether they will meet in June or not. The Executive can fix the exact date. Is it your wish that the convention shall be held in the month of June? Carried unanimously.

The President: The next order of business will be the consideration of reports. We will take up Mr. Breithaupt's report of the Committee on Statistics.

Mr. Breithaupt: Mr. President, the report of the Committee on Statistics suggests the formation of something in the nature of a bureau of mutual information to be formed in the interests of the members of the Association, particularly to gather information regarding central stations, and keep it on file. The central station men throughout the country are particularly the ones whom we ought to get into our Association, and we thought that we could find no better way of interesting them than by framing some such scheme as this, whereby they would be benefited. I think the committee has done a little good work for the Association in increasing its membership. During the past year, I believe a number of central station men have come into the Association. With these blanks that we sent out we outlined our plan to the central station men and asked them to come into the Association. Some of them have done so. Now, as to the method of carrying out this plan we had in view: It would be a little difficult to carry it out unless we had the Secretary do the principal work of it, that is, keep the information on file and keep it properly tabulated, so that any member of the Association wanting information could write to the Secretary for it. Some might want information on the prices usually obtained for supplying power, or whatever it might be, and central station men are very reluctant to give this information. The schedule of prices, of course, they are not at all unwilling to give, because it is published and is public property everywhere, but any detail of matters as to prices, etc., they are reluctant to give, and naturally enough. It was thought a man might want information, for instance, as to prices, what prices were in other places. He could state his case as clearly as possible to the secretary, who would advise him from which members of the Association he would be most likely to get the particular information asked for. He would then correspond with these other central station men, and being members of the Association, mutually acquainted with each other, and knowing the object of the information sought, we thought the information would, in all cases, be cheerfully given. All central station men have had considerable experience in this. We received a great many blanks from central station men answering in a very reluctant or uncertain way, and saying we don't know what it is to be used for, nor where it is to be used; and in most cases they did not fill it out at all. We all recognize it to be information which is of value to us, because in town contracts, where we have to renew, the town authorities are always talking about that, this, and the other place where they get light for very much less than we are supplying it; and generally they do not understand the details of the case, and simply say this corporation is getting light for less, and you have got to give it for that or we will get in another company to compete with you. If we could get the information in detail for such cases we would probably know why that corporation is getting cheaper light, and could then answer the authorities in that respect. I would like to hear the suggestions of the members on this point, particularly Mr. Hunt, who can give us considerable information along that line. This method is adopted in the National Electric Light Assn. He spoke to me about it yesterday, and there, I believe, they have derived very much benefit in that way.

The President called upon Mr. Hunt to speak, but he was absent from the room.

Mr. Kammerer: I think the scheme is an excellent one, for this reason: We have water power and we have steam power. In most cases where they have water power they sell the incandescent light more cheaply than where steam power is used, and if this information is secured in a statistical way, the central station man can talk to his customers and tell them that for that reason he cannot give them incandescent light at the same prices that a town plant 200 miles away can, because he has to produce it by steam. The consumer does not make it his business to find out whether the person is furnishing the light by using water or by using steam.

Mr. Armstrong: There is no doubt but that the scheme which Mr. Breithaupt suggests would be of great value to the industry generally. We are almost continuously in receipt of inquiries by companies renewing their contracts as to the prices paid and the conditions under which contracts are carried on throughout the country; and very often we are not in a position to give that information, because ordinarily we cannot get it on the same basis as the companies could directly, or as the Secretary of the Association could, in his official capacity. Referring to what Mr. Hunt stated to Mr. Breithaupt and myself last night as to the plan of the National Association, of which he is a member, he said that the Secretary, who was paid a proper remuneration for devoting a considerable portion of his time to the affairs of the Association, had, just in the way Mr. Breithaupt suggests, general information as to the conditions under which each of the central stations was carried on; and any member of the Association who was in difficulty of any kind, or wanted information as to the operation of his individual plant, could simply apply to the Secretary, and feel sure he would obtain the completest and best information, or a reference to central stations where he could get it, and at the same time feel it was the business of the Secretary of the Association to furnish him with that information. I think if any such scheme as this is carried on, that in the proper place we should consider the re-arrangement of the Secretary's position, so as to increase the remuneration to such an amount that the members of the Association would have no hesitancy in asking him for the information, and feel they had a right to expect it.

Mr. Kammerer: I fall in with all Mr. Armstrong has said, except the financial portion. If we are to remunerate our Secretary in a proper way for doing that work we would have to give him about $1,200 a year.

Mr. Armstrong: My idea was simply this, that our Secretary now does a great deal of work free for the members of the Association, and it seems unfair to pile a great deal more on him.

The President: Our Secretary suggests that if we had the information a great deal of it might be available without much additional expense. It does seem desirable that we should have such a bureau through which information which is reliable and authentic could be easily and promptly obtained. It is of vital importance sometimes to the central station men to know just exactly what light is being produced for, and all the rest of it, in neighboring towns. I hardly think the Association is in shape in its present condition to undertake that work. The work done by the committee under Mr.

Breithaupt will bear fruit, and I think it would be wise for us to let the thing simmer for another year, and for the present go on as we have been going, and probably by that time it will assume a more definite shape, and we will then be in a position to do something.

Mr. Breithaupt: Mr. Mortimer and I discussed this matter some time ago. The committee on statistics for the coming year, whoever they may be, should, I think, be willing to do a great deal of the work, particularly in formulating the nature of the information that should be gotten together; and to carry on the correspondence for the Association would not be such a great undertaking, because the number of central station men in our Association is not so very large as to take up a great amount of time. If the Secretary and the committee on statistics would co-operate, it seems to me that something might be done during this coming year on this work, and it is certainly a work that we should undertake. We have got to do something to interest the central station men in our Association. If the Association is not to be of mutual benefit to its members, what is it for? I think if we add $75 or $100 to the Secretary's remuneration, which, it seems to me, we are able to do, Mr. Mortimer would be willing to attend to the correspondence part in connection with it, and with the help of the committee on statistics, I think the matter could be taken in hand now.

Mr. Mortimer: Mr. President, will you let me say just a few words on this point. As Mr. Breithaupt says, he and I have discussed this matter to some extent, and I feel that the Association might be of very much more use and practical value to its members, especially central station men, if we had such a bureau as is proposed. I agree with Mr. Breithaupt that we cannot commence that work any too soon, and so far as I am concerned I am quite willing to do my share of that work for the coming year without any extra remuneration, to see how the thing works. After that, if it is a success and you see fit to increase my remuneration, all right. I would like to see that thing started, and to see the Association do some practical work, and anything I can do will be gladly done.

The President: Our Secretary is offering his services out of the fullness of his heart. I think very few of the members here realize the enormous amount of work devolving upon him, which he has performed. The remuneration we speak of is simply for the actual expenditure and not of being a remuneration for his services.

Mr. Breithaupt: Mr. President, I would move the adoption of this report.

Mr. Yule: I second that.

The President put the motion, which on a vote being taken, was carried.

The President: It is necessary that we have standing committees for the next year, and I would nominate Mr. A. A. Dion, of Ottawa, and Mr. J. A. Kammerer, of Toronto, to bring in a report this afternoon. The committees are on Legislation and Statistics.

Mr. P. G. Gossler: Do I understand from the adoption of the report that the Committee on Statistics will undertake the extra work?

The President: The committee will be continued and the work with it. We will now proceed with the first paper on the list entitled, "Meters" by Mr. James Milne. (See page 146).

Mr. Milne, on rising to read his paper, was greeted with applause. He said: In getting up this paper on meters I thought first of devoting the whole of it to chemical meters, but as the number of central stations using the chemical meter is very small, I thought we might just throw in the rest, as it were.

Mr. Milne's paper was fully illustrated by diagrams thrown upon a screen by means of the stereopticon.

The President: Gentlemen, the paper is open for discussion.

Mr. Rosebrugh: I would like to ask Mr. Milne if there would be any conscientious objection on the part of the company if they substituted silver for zinc?

Mr. Milne: I don't see that there would be any objection at all. Probably the cost would be a little more with the silver, but as long as the principle is the same, I don't see that there could be any objection.

Mr. Armstrong: Mr. Milne has certainly given us a very interesting paper. I think it must be a source of congratulation to Mr. Wright that he is able to meet such customers as Mr. Smith (referring to Fig. 8 in paper) when they kick about the mysterious results obtained from chemical meters, because he would certainly satisfy them that they must be wrong and the meter right. A very large part of Mr. Milne's paper loses its importance in view of the fact that the larger amount of current for incandescent lighting is supplied from alternating stations, and except the Lowrie Hall meter, which Mr. Milne did not go deeply into, and which is hampered by requiring a storage battery, there is no chemical meter that can measure alternating currents. In a place like Toronto, where direct currents are used, the chemical meter is all that is properly claimed for it, but I think Mr. Milne in his excessive zeal has gone somewhat beyond the general facts of the case in the claims for inaccuracy which he urges against the recording motor meter. The result of the Government Inspection tests which Mr. Higman, whom I see here, will no doubt be able to give us more fully, seems to show very good results indeed for the watt meters throughout the country. When you consider this, in view of the fact that many of them have been installed for several years, and not always under the best conditions, I think we have reason to consider the results as sufficiently accurate. There is one thing which I would point out in connection with Mr. Milne's awful example of a 500-light meter; such a building as that was used in would be a large office building in which a large number of the lights would be going continuously, sufficient at all times to run the meter. Mr. Milne goes on to state that the same conditions obtain through all the smaller sized meters, and I presume the same percentage for the number of lamps required to start the meter. There are in Toronto about 1,500 meters, and the number of lamps to be supplied from these would be about 35,000; that would make the average size a meter of 25 lamps capacity. If we allow Mr. Milne's claim that it takes twelve lamps to start the 500-light meter, that is only slightly over two per cent. of its current capacity. Taking the average as 25-light meters throughout the entire plant, the amount of current required would be slightly over half that required for the supply of one lamp, with the average sized meter. If Mr. Milne admits that, he admits that the meter perfectly fulfils its purpose, and that on the average it will start with less than the minimum possible load that can be put on it. There is a further objection in connection with the chemical meter for use in small stations which some stress should be placed on, and that is that the apparatus required for measuring the zincs is delicate and expensive in first cost, and in spite of Mr. Milne's assertion I do not think the ordinary lineman who is left to look after such matters would be capable of handling the delicate milligram scale used in connection with it. A good deal of the trouble which occurs in connection with recording meters, and I can speak more particularly of the Thomson meter, is on account of the careless manner in which they are installed. We had a case in point not very long ago. We shipped out a meter where they had not been using them before, and a complaint was received that it would not operate. We wrote enclosing a copy of the instruction book and saying that the plugs which held up the armature from the jewels should be taken out. They replied that they had not been taken out, and thanked us for the information. We heard later that the meter still failed to operate, and the complaints made about it were very severe, but upon investigation we found that the local expert had taken the meter up to the garret of the house and laid it down on its back. A Thomson recording watt meter won't operate that way. Leaving aside those failures to operate, which are the result of carelessness in installation, I think we may claim a very satisfactory general operation for the Thomson recording meters which are on the market. I do not mean to say that in large central stations using direct current, where the admittedly superior accuracy of the chemical meter can be obtained economically, that the recording meter should invariably be used, but for the general run of stations, we are obliged to put up with the recording meters, even though they are open to some of the objections that Mr. Milne states.

Mr. Thomson: How many stations in Canada are using this meter?

Mr. Milne: Three; Winnipeg, London and Toronto, I think. I would suggest in answer to what Mr. Armstrong says that it is not the general custom of the linemen to read meters in any central station of any importance. A man is generally detailed for that sort of work alone, and I think that any station that hires a lineman that is, a man that goes around putting up wires and the like of that deserves to have poor results from their meters. As Mr. Armstrong illustrated in the case of the man who laid the meter on its back, it means, of course, that to a certain degree, the results obtained from the recording watt meters are caused by carelessness. I might say that I think we have in Toronto the best men procurable for the meter business, and even with meters adjusted to almost perfection we have got some percentage of error right through; no matter what size, whether it be a 500-light meter down to a 5-light meter, we have the same percentage of error right down. We cannot ascertain whether the meter is registering correctly unless we put something in series with it to find out. I know by a large number of trials that when we put in the chemical meter the watt meter was slow in every particular instance. With reference to the taking out of the jewel, this cannot be done now unless the meter is taken down to the inspectors, so that they may see the seal broken. Everything is fixed up in first-class order before the meters are taken from the electrical inspector's office. I do not see that anything can be said on that point at all. In fact, we see that the meters are in the best possible shape before they are sent to the inspectors.

Mr. G. Black: I did not expect to take part in this discussion. I have a constant recording watt meter in Hamilton which represents the perfection of meters. I can certainly testify that it does record. I will say that it goes night and day, whether there is any current on or not, judging from the results. We have about 20 lights in my office, and I was told that they were 60-watt lamps. For a long time, taking the length of time these lights were burning, and counting for 60 watts per lamp, according to the record, I found that the meter seemed to read about 25 per cent. ahead of any calculation I could make.

Mr. Armstrong: Perhaps the lamps were not of the efficiency they were supposed to be.

Mr. Black: If I allowed about 100 watts per lamp it would agree with the meter's record. I think on any one lamp it will be sure to run. We had it inspected by the government inspector lately and sealed up, and the man who brought it back told me the inspector said it was all right, so I let the thing go and have not looked at it since. I would like to sell it to any electrical company to run up their dividends.

Mr. Wright: As against all these fine theories as to the watt meter we have the ghastly results of experience, and we cannot go behind the returns. Mr. Black has given us a case in Hamilton; I will give you another. In the city hall the company were running some lights in one of the departments. After a little trouble we persuaded the authorities to adopt the electric light throughout the entire city hall, and that necessitated a change in meters. The lights were used in the police station previously, and the proposition was to use them in the entire city hall. A change was made in the meters and the current was turned on in the entire city hall, but to the surprise of the company their bills were smaller than they were before all the city hall was illuminated. It depends on the meter being made of a size to accommodate the whole of the building. The lights used in the police station were six in number and were used during the 24 hours, under the previous circumstances, and the company got paid for it. When the larger meters were put in, the council, of course, meeting once a fortnight, when the six lights only were turned on, they did not register a scrap.

Mr. Armstrong: I think, as a matter of fact, a complaint of that character, so extraordinary and beyond the usual, would require the attention of the government inspector. I think that is an exception, and the meter must have had something wrong with it.

Mr. Wright: The meter was inspected by the government inspector. It was carried there as carefully as it could be carried; it was installed with a spirit level; it was not set on its back or put upon its face, and all precautions were taken, and that is the result. It is very plain to see the reason, as Mr. Milne has stated in his paper. And that state of affairs occurs to a greater or less degree in every installation. You take a delicate piece of mechanism like an electrical meter, box it up so that you can't see it or do anything with it, and expect that thing to run without any attention, and it is out of all reason. The utmost that I ever expected to get from the watt meter when the watt meter was first introduced, was an approximate idea of the current that the customer used, and I will defy any person who has had any experience to say that that is not so, that the utmost you can expect to get is an approximate estimate.

Mr. P. G. Gossler: In regard to the reliability of recording meters: since the law has been brought into action it has been necessary for us to go about changing all of our meters, and we have installed the Shallenberger meter. Since last July we have changed from about 900 to 1000. When they were installed each meter was inspected and the number of lights necessary to make them record was entered in the record book, and when they were brought in they were also checked off. While we have found some instances where the meters have become clogged through dirt or cobwebs, the results have been so satisfactory that we have no complaints to make. The question of allowing them to run without any attention, of course, cannot be considered. In a large installation it is necessary to read your meters. Of course we read our meters according to the customer: some monthly, some quarterly, but none over six months. The men who are employed in that capacity, and also checking out the bills, have become to so thoroughly know what should be expected that in case of any falling off in the recording meter it is generally very readily noted. I have an instance that came to my attention on Monday. We installed for three months a government inspected meter; we knew that the man had installed fourteen lights and we had an idea of what his bill should be. Of course, it would only be an idea. His bill did not come up to what we expected and we immediately proceeded to investigate and make a test. Investigation of the meter showed that the light ran on whether the meter was recording or not. Still further investigation showed that there was a wire under one cleat short-circuiting the meter. We have found the reliability of those meters very satisfactory, especially during the last year, when we have had occasion to change and are changing all our other meters in the service.

Mr. Armstrong: I should like to ask Mr. Milne whether he intends in his paper to attribute this unreliability which he complains of to the Thomson recording meter alone.

Mr. Milne: The only meter that I know of so far in this country as recording watts is the Thomson watt meter; therefore the remarks, as far as I am personally concerned, apply to the watt meter. In all installations where the watt meters are used they must be of sufficient capacity to carry the maximum load with safety. Take for instance the Grand Trunk station. There are probably 1000 or 1500 lights there; we will say 800 to make sure. We had to put in a meter of sufficient size to carry that. During the day there are about from 10 to 25 lights used, and, as a positive fact, that meter certainly did not record on fifteen lights.

Mr. Armstrong: What size was it?

Mr. Milne: It was 160 amperes: I think that is the size of it. When we put in the Edison meter we found exactly where the trouble was. I knew for a positive fact they were using light every day in their engine-room, although we could not get any record on the meter. All we could do was to put on the chemical meter to find out. There was no negligence or carelessness in the installation of the meter. It was put up dead level and according to the instructions sent out by the company where it says, "Don't suppose you know it all." We take it for granted that we do not know all about it and simply follow the instructions sent out by the company, and in doing so that is the result we get.

Mr. Armstrong: Of course, Mr. Milne in the Grand Trunk case gives an instance of a very large meter, and the number of lights on which it fails to start is less than 2½ per cent. of its total capacity. I presume Mr. Milne in speaking particularly of the watt meter is speaking of it from his own experience in Toronto. It being the only meter in commercial use for recording direct currents, it is the only one that could be used in connection with their three-wire circuits. I know it is not in accordance with the facts, or the result of the Government inspection of meters generally in Canada, that the watt meter has shown itself to be in any way less reliable in giving accurate returns than the other simple recording ampere meters; in fact, the results have been precisely the contrary. I should like to ask Mr. Hunt's experience with the watt meter; he has a great number of them installed.

Mr. Hunt: We have about 400 of the Thomson watt meters in use. I think they have all been in use for an average of eighteen months, some of them over two years, and about ten per cent. will run slow, and I think we have only one out of the lot that has run fast.

Mr. Milne: May I ask Mr. Hunt how he determines that amount? We would have something definite to go on. We have the chemical meter to prove that the watt meter is out that amount. How does Mr. Hunt determine it was out about ten per cent.?

Mr. Hunt: By the Government inspection, that is all.

Mr. Dion: I think that the cases stated by Mr. Milne and Mr. Wright are rather the exception than the rule. I do not think there is any mechanical device, no matter how accurate, against which such cases could not be brought up. If we go around the country looking for cases of failure, we are sure to find some, but I do not think they are the rule. We have in our city some 3,000 meters, I suppose two-thirds of which are Shallenberger, and the other third watt-meters. We have lately had occasion to have a very large number of these inspected by the Government. We test them at our office first and send them up to the Government afterwards. In many cases we find that those meters which have been in use from a few months up to five or six years are turning out very satisfactory. I don't suppose there are any more than from three to four per cent. that have to be touched at all before sending them for inspection. I think fully 95 per cent. register within the percentage allowed by the Act. We do not send them up until they are correct, because we do not want to pay the fees twice. With regard to the two meters, in answer to what Mr. Armstrong has said, I may say that while there has not been a very great difference, in our experience, between the two meters, in testing them, the difference has been rather against the watt-meter. The percentage of meters requiring fixing up before being tested by the Government was larger in the case of the watt-meter. The meter had to be fixed up, because it either didn't start with one lamp or went too slow. Leaving out this question of the relative merits of the meters, I would like to say a word in praise of the paper we have just heard. Its value lies in the fact that it keeps before us the defects of the apparatus which we use every day, rather than the qualities of them. I think it is only by keeping the defects constantly before us that we may expect improvements to be made. I also think that Mr. Milne is very wise when he advises that all currents should be used through a meter. I think that should be the universal practice, and should be encouraged by all possible means. When all the current is used through a meter you will find that it is a considerable relief to the central station. Our experience in that way is very satisfactory. We urge the meter in all cases, with the result that a very large per cent. of our business is done through meters. We find that with an installation of 54,000 lamps our largest loads have not yet exceeded the equivalent of 22,000 lamps; that is, the actual ampere meter readings, and it includes all losses from leakage in transformers, so you see the importance of using meters throughout the installation. As regards flat rates: There are some cases where it is absolutely necessary to make a flat rate, and in these cases the maximum use is the thing we want to get at; and if there could be such an apparatus devised as Mr. Milne has described as recording the time during which the lights are being used if that could be so improved as to give the maximum load as well, it would be a very valuable adjunct in the case of flat rates. We could then make a rate very intelligently, which would be almost as good as a meter rate.

Mr. Wright: I would like it thoroughly understood, of course, that what remarks I have made in regard to these meters are not intended to apply to any particular brand of meter. For instance, the Thomson recording watt meter, considered in the abstract, is a most ingenious piece of mechanism. My remarks apply to all meters of the same description which depend on jewel centres and absolute accuracy of installation for their perfect working. We are compelled to take these meters. In one respect I may say perhaps our experience in Toronto differs very greatly from places like London and Ottawa, where watt meters are used almost exclusively in lighting systems where there are a comparatively small number of lamps. But you take the case of an installation in Toronto for motors and for elevators, where a sudden load is sometimes thrown on the meter in starting an elevator or a large motor, more than it is capable of bearing and more than it can be expected to bear, it happens in very many cases, in fact, in nine cases out of ten, the resistance will be burned out. What can you do? The meter is sealed up. You cannot get at it. You replace the burned-out part, take it to the inspector's office again, and the fee is $2. And so it goes. My remarks in regard to these meters do not apply to the Shallenberger meter or to any other alternating meter without a commutator and without any trouble arising in the armature. There is no doubt that if we could confine ourselves to a meter of that description I do not think anybody would object. When we are compelled to put in a meter that we know will under extraordinary strains give us trouble, then the "coercion" comes in. If the Government would provide us with a meter that would work, and that would not be sealed up, I say it is perfectly right for them to inspect them, for the sake of protecting the poor consumer, but they should not compel us to lock up a machine that is going to be unreliable and that we cannot attend to.

Mr. P. G. Gossler: We had some Thomson recording watt meters installed, and we found it necessary to remove them because we could not record the loads. That applies only to loads varying very greatly.

Mr. Thomson: We placed recording watt meters on the motor circuits, and inside of a year's time we found about half of them burned out, so we discontinued the use of meters on all of them.

Mr. Wright: We have been obliged to resort to a flat rate, to our loss, and rather than instal a watt meter under certain conditions we have been driven to the use of the Pattee recorder. I am not blaming the watt meter, but simply because we cannot get a meter that can be sealed up which we can depend on to give us reliable and accurate data to charge up. We size it up in our imagination. We never salt a man any more than we think he can stand. We put in one of these lamp-hour recorders and magnets to suit, and he is chopping his wood and doing all that sort of thing by the hour. We find in a measurable degree it answers the purpose.

It certainly answers the purpose better than a Government inspected meter.

Mr. Milne: The Thomson meter is the most ingenious meter we have in the market to-day, but it is not applicable for our purposes here in Toronto.

Mr. Higman: I have just had this paper placed in my hands. After luncheon I suppose we will be able to take it up, and I will have something to say.

The President: I think the opinion of the members present is that we ought to adjourn this discussion. It is probably one of the best discussions we have ever had in a convention, and it does seem a pity to end it here, more especially as Mr. Higman is here and we would like to hear from the Government Inland Revenue Department. Is it your wish that the convention stand adjourned until two o'clock?

Mr. Dion: The point which has been raised by the paper just discussed is whether the Government was justified in shutting out the electrolytic meter, which is admittedly the most correct meter. This point can be very well discussed under the item on the programme, "Consideration of the Government Inspection Act."

Mr. Higman: I think the whole subject had better be discussed on this paper.

Mr. Armstrong: I have very much pleasure in moving a hearty vote of thanks to Mr. Milne for the very able paper he has given us. I believe that the discussion took a turn that was not expected, and which resulted in bringing out points that will be of interest and benefit. I do not agree altogether with Mr. Dion as to the desirability of the general use of the meter throughout the country. I think in connection with many of the small installations the certainty of their securing a revenue throughout the year, especially where they are operating by water power, is more desirable. I have pleasure, gentlemen, in moving a vote of thanks to Mr. Milne.

Mr. Kammerer: I second the motion.

The President: It has been moved by Mr. Armstrong, seconded by Mr. Kammerer, that a hearty vote of thanks be tendered to Mr. Milne for his valuable paper, which I am sure will be carried unanimously. (Carried.)

The President stated that a photograph of the members of the Convention would be taken at Lorne Park in the evening.

Convention adjourned until 2 o'clock, p.m.

AFTERNOON SESSION.

The Convention was called to order at 2 o'clock, p.m.

The President. I will be glad to receive a report from the Committee on Nominations for the Standing Committees for the year, legislation and statistics.

Mr. Dion: I beg to report as follows: Legislation Committee—Messrs. J. J. Wright, K. J. Dunstan, Berkeley Powell, L. B. Macfarlane, and F. H. Badger. Statistical Committee Messrs. E. Carl Breithaupt, John Yule, and O. Higman. I may say these are the same as last year, they have done so well we thought we would keep them in office.

The President. It is hardly necessary to read the names again. Is it your pleasure that these gentlemen should form the committees on legislation and statistics to carry on the work for the coming year that was carried on last year?

Mr. Breithaupt: I have been on the Committee on Statistics for two years, and have given it considerable energy and thought. I have carried it about as far as I can. Somebody else may have different ideas from what I have, and would be able to carry it further. As far as I am concerned I think some one else might be put in my place.

Mr. Higman: I have been two years on it, Mr. President, and while I cannot say that I have given as much energy as Mr. Breithaupt has to the work, still I would rather have somebody else in my place.

Mr. Armstrong: The reason which these gentlemen give for retiring is the very reason why they should stay on. They are the only people in possession of the necessary information as to the method of procedure.

The President: I hope Messrs. Breithaupt and Higman will withdraw their wish to resign. The work they have in hand is advancing very nicely, and it requires but a little more to put everything in very good shape. I think the Association would appreciate their efforts if they would continue. I suppose silence gives consent, and we will consider these gentlemen as elected to these committees.

The President: The next order of business will be nominations for President.

Mr. Kammerer: I have much pleasure in nominating Mr. John Yule, one of the initial members of the Canadian Electrical Association, as our next President.

Mr. Milne: I beg leave to nominate Mr. E. C. Breithaupt as President.

Mr. Breithaupt: I very much thank my mover for mentioning my name for the honorable position of the Presidency, but I think Mr Yule deserves this honor more than I do. He is one of the charter members of the Association. I beg, therefore, to withdraw my name in favor of Mr. Yule. (Applause.)

Mr. Yule being the only nominee for the position of President, he was elected to the office by acclamation, amid applause.

The President: I am sure it is a matter of congratulation to me personally that Mr. Yule will succeed me in office, and I have much pleasure in announcing Mr. Yule's election.

Mr. Yule: I beg to thank you for the compliment you have paid me in electing me to the office. I did not wish to accept the office, but it seems the general wish that I should do so, and in doing so I would ask the members to give me the same support as they have given to the other Presidents. The election of Presidents has generally been heretofore from amongst members residing in the central constituency. The office has formerly been in Toronto, and the work has been carried on very efficiently in that way. I do not know how it will work with a President residing at a distance. A great deal of the work will fall on Mr. Mortimer, and I will have to look to him to keep me straight. I would also ask the members here to elect a very fair contingent of the Executive Committee from the members residing in the city of Toronto; it has worked very successfully before.

The President: The next nomination will be for Vice-President.

Mr. Dion: I beg to nominate Mr. L. B. Macfarlane, of Montreal, as Vice-President.

The President: I may say, in all fairness to Mr. Macfarlane, that I had a letter from him this morning, in which he regrets his inability to be present, and regrets still more his inability to attend any of the meetings during the past year, and asking that as a personal favor his name be dropped. I do not think we ought to take any notice of that letter at all.

Mr. Carroll: Not at all.

The President: He is too valuable to be dropped out.

Mr. Wright: Mr Macfarlane has been one of the useful members of the Association. He has always taken a great deal of interest in it, and until the present time has been present at every Convention. I should like very much to see Mr. Macfarlane's nomination made unanimous.

Mr. Macfarlane was then declared elected to the office of first Vice-President of the Association by acclamation.

Mr. J. J. Wright: I beg leave to nominate Mr. E. Carl Breithaupt for the office of second Vice-President.

There being no other nominations Mr. Breithaupt was elected unanimously to the office.

The President: The next officer to be elected, and one of the most important, is that of Secretary-Treasurer.

Mr. Carroll: Oh, that is settled.

Mr. Breithaupt: The Secretary-Treasurer that we have had for a number of years past, in fact since the formation of the Association, has done very much in the work of carrying on the Association, keeping it on its feet, and making it what it ought to be. I feel we would be doing a great wrong in not keeping him. I therefore move that Mr. Mortimer be elected by acclamation as Secretary-Treasurer for the coming year.

Mr. Mortimer was then elected by acclamation to the office of Secretary-Treasurer.

Mr. Mortimer: I thank you, gentlemen, for this, the fifth or sixth time, of the very kind expression of your favor.

The President: The next thing is the election of the Executive Committee. It is desirable for many reasons that there be a continuity in the membership of the Executive, and for that reason five of the ten must be selected from the present list. The five who in your estimation deserve consideration at your hands, are to be marked, and the remaining five will be nominated and elected afterward. Our constitution says that the method of procedure in this case would be that the Secretary shall read the names, and the person, as his name is read, shall rise and deposit his ballot. This of necessity would prolong the Convention, and as active members only are allowed to vote, and to shorten the proceedings, I would appeal to the honor of those who are here that no one shall vote who is not entitled to, and the ballots will be distributed and collected. Before doing that it is necessary to appoint two scrutineers, and I would nominate Mr. Geo. Black and Mr. Geo. White-Fraser to act as scrutineers.

Mr. Breithaupt: At the Convention last year I thought that it was decided that the members of the Executive Committee were to be elected for two years?

Mr. Carroll: That was the intention of the by-law, but it was changed.

Mr. Breithaupt: How is it now?

Mr. Carroll: They have got to be re-elected every year.

Mr. Wickens: Yes, but five members of the old board have to be re-elected.

The President: As Mr. Breithaupt has been elected to the office of Vice-President, he will not now be eligible for election on the Executive.

Mr. Wickens: While the ballots are being collected, I move that $50 be appropriated for the use of the Secretary-Treasurer to meet the expenses in connection with the work of the Association.

Mr. Kammerer: I second the motion.

Mr. J. W. Taylor: I do not know that that sum is sufficient.

Mr. Breithaupt: The sum that has been set apart heretofore has been $50.

The President: It was formerly $25, but last year at Ottawa it was made $50, and we propose this year that it should be the same.

Mr. Breithaupt: The Secretary-Treasurer has more work to do, and I would move that the sum be made $75 instead of $50.

Mr. Higman: I moved at Ottawa last year that the sum should be made $75.

Mr. Wickens: Under all the circumstances I will withdraw the original motion and Mr. Breithaupt's amendment can be put as the main motion.

The President: As far as money is concerned, I am quite satisfied that money could not pay Mr. Mortimer for all he has done for this Association, and I shall be delighted, personally, to have the sum made $75.

The President: It is moved by Mr. Breithaupt, seconded by Mr. Taylor, that the sum be made $75. Is that your wish?—Carried.

Mr. Mortimer: I may just say in regard to this question of remuneration that I do not want to see this Association bankrupt, and I think if you go on putting up the Secretary's salary every year it is going to bankrupt the institution. I think we had better let the salary stand as it was, and if we find at the end of next year that there is anything left out of that "$29,000 surplus," I will take what is offered.

Mr. Wickens: I don't agree with that at all; I think the association is good enough to make up the difference.

The President: The following members are elected to the Executive in the order in which I read them: Messrs. J. J. Wright, A. M. Wickens, K. J. Dunstan and J. A. Kammerer, and for the fifth position there is a tie. On the casting of ballots by two members who had been absent from the room, the position of fifth member of the Executive was accorded to Mr. Geo. Black, of Hamilton. The nominations for the remaining five members of the Executive were then proceeded with.

Mr. Breithaupt: I have much pleasure in nominating Mr. Hunt, of London.

Mr. Wickens: I nominate Mr. F. C. Armstrong, Toronto.

Mr. J. J. Wright: I nominate Mr. A. B. Smith, Toronto.

Mr. Kammerer: In view of the fact that we have decided to go to Niagara Falls, I have much pleasure in presenting the name of Mr. Ross Mackenzie.

Mr. A. A. Dion: I beg to nominate Mr. J. W. Taylor, of Ottawa.

Mr. Carroll: I nominate Mr. Dion, of Ottawa.

Mr. Armstrong: I have much pleasure in nominating Mr. John Carroll, of Montreal.

Mr. W. A. Johnson: I beg to nominate Mr. Milne, of Toronto.

Mr. J. J. Wright: I nominate Mr. W. A. Johnson, of Toronto.

Mr. Carroll: I beg to propose Mr. E. C. Cary, of St. Catharines.

Mr. Armstrong: I beg to nominate Mr. W. Williams, of Sarnia.

The President: While the scrutineers are doing their work in this connection I think we might go on with our proceedings. The first thing to be considered is "The Government Inspection Act." If anybody here is prepared to say anything the meeting is open for that purpose.

Mr. Higman: With reference to the paper that was read by Mr. Milne this morning, I notice that while it contains nothing very new, yet the facts are arranged very satisfactorily, and the deductions that he has arrived at are most convincing, viewed from the standpoint of Mr. Milne and those who employ him. Running through the whole paper, and underlying almost every paragraph, we detect the fine work of the special pleader. From beginning to end it is a plea for the electrolytic meter, and from that standpoint I think Mr. Milne has succeeded very well and has earned the thanks of his employers. He says the electrolytic meter has been condemned. He might have added that it has been very generally condemned both in England and the United States for every-day practical use. He says consumers do not want to keep a record, an exact record, I think he says, of the supply. They do want to know, however, to what extent they are using the current; they want to be able to determine from time to time what the rate of consumption is. I think that is very reasonable, and it is not surprising that they should ask for a direct recording meter. In regard to that very question we have received at the Department dozens of letters complaining bitterly about the use of this meter. We have received several such letters from Toronto and Kingston, asking that the Department put a stop to their use at once, instead of allowing them to run almost indefinitely. And while Mr Milne designates the idea, in regard to renewals, as renewing the whole meter, as "gross rot," anyone who knows anything about it will agree with the proposition that to renew the plates is to practically renew the meter. Mr. Milne makes some complaints as to the unit of current. May I ask if there is anything wrong with the method of determination as laid down in the Act?

Mr. Milne: The definition is perfectly right, and the method of arriving at it is correct.

Mr. Higman: A paragraph in Mr. Milne's paper says "The Government has to raise a revenue, that is settled. The gas companies contribute a certain percentage of that revenue; the electric companies are their greatest competitors, therefore we can readily infer that any little obstacle that can be put in the way by such companies will be done so, and it is very common property that this Act was the result of the gas companies." I deny that, as far as I have any knowledge of the papers. I have seen all the papers that have been sent to the Department in connection with this subject, and I have failed yet to discover a single word or line from any gas company asking for an Act of this kind. Mr. Milne's statement is not borne out by the facts. I might say in connection with the question of fees that in Canada there are thirty-seven gas companies, and from these thirty-seven companies we collect a revenue of some $14,000 to $15,000. At present there are two hundred electric light companies registered under the Registration Act, and from them we expect to collect about $4,000 a year. During this year we shall have more than that, because of the order that was passed, asking that all meters be verified before the 1st of July, but after this year we shall not collect more than about $4,000 or $5,000 a year from the whole country, taking in about two hundred and fifty companies; so that as compared with gas companies the latter not only pay a certain percentage, but nearly the whole thing. Mr. Milne asks among other questions, "Are there any advantages to be derived from this test?" and answers it in the affirmative. I would like to ask Mr. Milne if that is his opinion to-day? Whether he is in favour of having the inspection? I will pause for a moment to get his reply.

Mr. Milne: The answer to that, as far as I know, is in the affirmative yet; the inspectors are benefited. I don't see that it benefits any one else.

Mr. Higman: It is not a very fat thing for the inspectors. Up to the present time, although their work is nearly double, they have not received a cent additional remuneration. Notwithstanding what the inspector derives from it, I am inclined to think that Mr. Milne would not refuse the job himself.

Mr. Milne: No, sir. In fact, I applied for one of just the same kind.

Mr. Higman: Now, a word or two in reference to the difficulty mentioned by Mr. Wright. I admit it is a real difficulty and one that has engaged the serious consideration of the Department. Some time ago I suggested to Mr. Nicholls that perhaps the difficulty could be overcome by hinging the bevelled piece of the case immediately below the dial plate. This opening could be sealed by the company. It would enable them to get at the commutator to clean it at any time, and such opening would not affect the registration in the slightest.

Mr. Wright: That would work all right if the Government would be content. Speaking for the company that I represent, I don't think the company would order any subordinates to go around and spin the meters ahead at all.

Mr. Higman: I did not mean that. I don't think the Government would have any objection to that, because the consumer has it in his own hands. He is always there when the company's representative goes around, and there could be no objection at all to having this opening in the meter to clean it. I would suggest that in matters of this kind the association should appoint a committee, and if there are any grievances to be remedied or considered, to wait on the officers of the Department and see if some means cannot be found of overcoming them.

Mr. Milne: Mr. Higman says he has received several complaints from Toronto regarding the chemical meter. It is astonishing that we did not hear of them, when we have so very few complaints here. I would just like to ask who are the parties using the chemical meter here in Toronto who have been doing the complaining. I think you will find that it is a customer who does not wish to pay for what he is using. No company, I am sure, will charge for more than what is honestly burned, but they certainly wish to get paid for what goes through the meter. Mr. Higman is of the opinion that renewing the plates in the chemical meter is practically renewing the meter. If we had to supply five pointers for a recording meter, is that supplying a new meter? The meter itself is composed of a German silver shunt; in multiple with this shunt is placed a compensating spool: in series with this spool is placed an electrolytic cell in which is placed two plates. The two plates are a very small arrangement as compared with the meter itself. I cannot see how renewing the plates in that meter is practically renewing the meter.

Mr. Higman: You cannot use a meter without the plates; it is the only part that needs renewing.

Mr. Milne: Mr. Higman speaks about the inspectors verifying the meters at the station. I think it would be a good idea for the inspectors to go to some of the stations and have their meters verified, because in the principal stations here in Canada the very best meters procurable are put in. It is not to the interests of the company to run below the voltage, nor it is not to their interests to run above the pressure; that would simply mean increased lamp renewals, and if they run below the light is poor. If we run above pressure that is a loss to the company, and not to the customer.

Mr. Higman: Certainly. That was my contention. We want to save the company any loss.

Mr. Milne: I think the companies will look after that in good style. In the letter which Mr. Higman wrote to the ELECTRICAL NEWS last month he says one of the inspectors called at a station, and found that the meter was four volts out. A station of that kind deserves to be soaked just for as much as the law can give in running instruments of that kind.

Mr. Wright: In the first place my objection is not to the Thomson watt meter as a meter, and I am not objecting to Government inspection as Government inspection. I must say this, and I am bound to say it in all fairness, that in all our communications with the Department and with the subordinates, we have been treated universally with great consideration, and the inspectors have acted in a gentlemanly way all through to the best of their ability. It is the combination of the two that makes the trouble; it is taking a meter that will not operate and locking it up in a glass case and expecting it to operate, and the Government Inspector coming along and saying that it has got to operate. It seems to me the suggestion of Mr. Higman is a good one, that some means of access to the delicate parts of the meter should be provided. If that is done it takes away a good deal of the force of the remarks that have been made. We have no objection to the Government seeing that the meters are right, but it is manifestly unfair to take a machine that requires attention, that should be opened and carefully cleaned, and the brushes and commutators attended to and put on the home stretch for another run. I say it is unfair when that meter is sealed and shut up and that cannot be done. If some method can be got at, and if the Government are willing to allow some means of access to the delicate part of this mechanism, that gets over the major part of the difficulty. I am speaking from what I find. It is a heart-breaking job when you have to handle the number of meters we have here in Toronto, and under the conditions in which we are expected to handle them; in fact, it is enough to make a man give up in despair. The meter is sealed up, and is supposed to be right. It possibly gets a little jar in being taken to the place of use, or getting it up on the side of the wall, and it does not read correctly, and there is no way, according to law, of having that remedied. They are entitled to charge a new fee for inspecting it again if we take it back. If some method could be adopted by the Government inspectors so that when a meter is brought to them, after it has been in use for a short time, it could be reverified without expense to the company, I think it would be well. Some of these meters, if we did not take them out, would be an eternal source of expense; it would be pay, all the time, to have the meters verified. Let me say just one word about the letters M.. Higman has received. I have no doubt he has received them, because I have received similar ones, and it is altogether likely the parties in sending them to me have communicated with Mr. Higman; they probably would have written also to Queen Victoria and Lord Salisbury; but when the Government has got a clause in their Act which says that every man is entitled to a direct reading meter if he demands it, what is the kick about?

Mr. Higman: I don't know. It is Mr. Milne that is kicking.

Mr. Wright: When a man has an objection to a chemical meter, and says I want something I can read myself, we meet him, so that the force of these complaints is lost. I just want to make my position plain in this matter. It is not a question of finding any fault with any particular brand of meter. It is very far from my intention to criticize the action of the Government or the officials. We have always been treated as an Association and as individuals with the utmost consideration by the Government officials, but it is the combination of the two where the difficulty arises. If the Government will adopt the method Mr. Hignam suggests I will have no doubt that will overcome a good deal of the difficulty. I move that the Legislative Committee of the Association take up the matter with the determination, if possible, to see if any mutual arrangement can be made to make the matter more satisfactory.

The President: When two parties are favorably disposed there is always a way of coming to an arrangement which can be made mutually advantageous. I know Mr. Higman has a difficult task to perform, and his inclination is to do justice to all concerned.

Mr. Higman: Before sitting down I would like to read a letter from one of our inspectors who thinks he has been rather unfairly treated, and he wishes to be set right before the Association. The letter is as follows:

O. HIGMAN, ESQ., Ottawa.

"SIR: Your favor of yesterday has been received, asking if I know to whom a certain article in the ELECTRICAL NEWS refers. I have already received a copy of the NEWS with the article in. It may refer to me, but I must say I have not interfered directly or indirectly with the electrical plant or apparatus of any electrical work in Hamilton or elsewhere. What I have done is this: About a year ago I met on the train Mr. Robert Thompson, President of the Electric Light Company, and in course of conversation he spoke of the excessive amount of fuel they were using under their boilers. He said I must, when in the business, have had practical knowledge of this subject, and asked me what was the cause of using so much fuel. I suggested that possibly the chimney was too small for the services required of it, and that I had some books on the subject which I would be willing to lend him. He said that Mr. Knox was the mechanic of the board, and that he would send that gentleman to me. Mr. Knox called and I showed him the books. I directed him to the places giving the size of the chimneys needed for similar plants, and told him he might make the calculation for himself. He copied the figures, thanked me for the use of the books and went away. Both these conversations were sought. I did not volunteer any information, and had nothing to say except the suggestion that possibly the chimney was not of sufficient capacity, it having been built for a much smaller boiler. This was about ten months ago, and I have not since spoken to any of the directors nor to other persons on the subject. I have not at any time in the remotest way offered my criticism or advice in connection with electrical matters. It would be presumption on my part to do so. As a practical mechanic I offered the suggestion to friends seeking my advice.

I am, yours, etc.,

D. McPHEE.

Hamilton, Ont.

Mr. Wright: Isn't that the case of the cap fitting the man?

Mr. Higman: I may state that the letter is in reply to inquiries made from the Department to the inspector.

Mr. Johnson: I would move an amendment to the last resolution, that is, that the question of removing the bond from the chemical meter be taken up. If the Government can be induced to do so, that chemical meter has a use for direct-current work and for power work; it is something that is very handy to use and there is the possibility also that it may be desirable to have it in connection with alternating work.

Mr. Fraser: I want to refer to one individual case that I know of myself. The inspector, whose name I shall not mention in public, but I will give it to Mr. Higman if he desires, managed to and purposely left the impression in the mind of a man who was just putting in an electrical plant that it was necessary before accepting the plant that it should be passed upon by the Government inspector. The purchaser was an ignorant man and the inspector was ignorant, if not more ignorant than the purchaser, but the purchaser was a perfectly creditable man, and told me distinctly that this inspector had purposely left him under the impression that the Government inspector was placed as a kind of watchman over the manufacturing companies, and it was necessary for him to pass that plant before the purchaser would buy. These inspectors have got no standing in the profession, but they go about with the influence and the weight which is given to them by the Government appointment and use that in a very wrong way.

Mr. Higman: I must say I am surprised to hear the statement just made. I can hardly understand that one of the inspectors, knowing very little about electricity, and necessarily so, should even attempt to pass judgment on matters of this kind. The Act contains no provision for the inspection of electric plants; it deals only with the public supply and the apparatus through which the supply is determined, and on which the consumers' bills are based. Applications to the Department have been frequently made, however, for the services of an electrical engineer to report on one thing and another, simply, I presume, for the reason that such services would be rendered free of charge. In every such case I have referred the parties to practising electrical engineers outside the Government service.

Mr. Black: I had a conversation with Mr. McPhee the other day in reference to this matter, and he explained it to me as he has written to Mr. Higman. The advice was sought in such a way that he could not refrain from giving some kind of an answer. He did not give his answer as Government inspector or official, but in the light of his past experience as to steam feeders, for he had a large experience in the feeding of similar heating apparatus. There was one instance where there would have been a loss of a thousand dollars on the plant if he had not studied up the subject and found the fault lay with the chimney, and convinced the Government officials, who had reported against him, that the fault was with the chimney. He had works on the subject, and he simply suggested that there might be some trouble of that kind, and loaned his works to these parties. He had no thought of acting as a Government official at the time, and he certainly did not intend to pose as an electrical engineer. He would have been at this convention only he felt it would be better for him to remain away during this discussion.

The President: An amendment was moved by Mr. Johnson, seconded by Mr. Wickens, that the Committee on Legislation also consider in their correspondence with the Government and Government officials the reinstatement of the chemical meter, as being useful for power on other circuits.

Mr. Breithaupt: Would it not be well to make that a little more general and say the committee shall have power to meet and confer with the Government authorities on the matter of electrical inspection and on all matters concerning the same, so that they may be able to deal with any exigencies that might arise?

The President: I see no reason why it should not be carried out.

Mr. Higman: I would suggest that if the committee wait on the Government that they give their complaints, or whatever they want, in detail. It is no use taking up the bill and discussing the whole thing over again, because you arrive at nothing; but if there is anything of a special nature that you wish to have changed, or discussed with the Government, let it be specifically stated.

Mr. Wickens: This is within the province of our legislative committee, and if there is anything that we wish to have changed, I think it is for them to take up the matter. I am satisfied they will do what is right. It seems to me that the matter could be arranged so that it would be reasonably safe to the consumer and reasonably good for the producer. The object of having a law of this kind is to do some good by it, and the object of this Association is to help the members and help the people in connection with their interests to do what is right, and to succeed. I think the committee should be able to go into that matter with a free hand, and I think the Government should be able to meet them as representing practically the whole of the electrical people of the country. I think the Government should meet them, and I think they will.

Mr. Dunstan: As a member of the Legislative Committee, I think it is not a question that should be left in the hands of that committee. It is a technical question in connection with electric light interests, and I think there should be a special committee appointed.

The President: Mr. Dunstan's point is well taken. That committee should, I think, be composed exclusively of electric light men interested in that actual work. I think it would be proper now that a committee of three or five be nominated to take the matter in hand.

Mr. Milne: Mr. President, I would just like it understood that I have no particular hatred for any mechanical recording device. I have a particular love for the Edison chemical meter. My paper was originally intended to be on the chemical meter, but I thought it might interest some of the members of this Association to know the principle on which some of the other meters were worked, and as far as we are concerned here in Toronto we have had the most friendly relations with the inspector. I think we can get along first-class with him, and we have no friction at all in any respect. I think Mr. Higman will admit that. It was just simply in connection with that restriction of the chemical meter that I got up this paper.

The President: The nominations for the remaining five of the Executive Committee are as follows, and they are elected in the order in which I read them Messrs. Ross Mackenzie, Niagara Falls; A. B Smith, Toronto; John Carroll, Montreal; Charles Hunt, London; and F. C. Armstrong, Toronto.

Mr. Breithaupt: I would suggest Mr. J. J. Wright, Toronto; Mr. P. G. Gossler, Montreal; Mr. A. A. Dion, Ottawa, as a committee to interview the Government.

Mr. Armstrong: I would suggest adding Mr. James Milne, who is probably more thoroughly conversant with the subject of meters than anybody else present.

Mr. Breithaupt: I thought the committee would want to be very small. Mr. Milne would certainly be a good man to have on the committee; I would like to see him there.

The President: I think Mr. Breithaupt would do good work on that committee; that would make five.

The President put the motion, which on a vote being taken, was carried.

The President: We will take up now the paper by Mr. Armstrong entitled "The Outlook for the Electric Railway." (See page 15.)

Mr. Armstrong's reading of the paper was followed with applause.

The President; You have heard this very valuable paper of Mr. Armstrong's; the subject is a live one and I would like to have some discussion.

Mr. Hunt: I have great pleasure in moving a vote of thanks to Mr. Armstrong in having prepared his valuable paper on electric railways.

Mr. Wyse: I second that.

The motion was carried.

Mr. Fraser. I think Mr. Armstrong has given us a fair account of the position of electric railways in Canada. In the last paragraph he mentions something in connection with long distance railways. I think it would be quite interesting to the Association to hear some of the facts in connection with the electric railway at present running in Lugardo, which is described in some of the technical journals recently. They do not use the rotary transformers in connection with their system, but it is actuated by the direct three-phase currents. As to the question of the track, that seems to have been successfully overcome. In fact, I believe there are a good many of the best electricians of the day who have arrived at a practical, if not an actual and commercial solution.

Mr. Hopkins: There is one question I would like to ask Mr. Armstrong. He spoke of the limit of the field of the road radiating out. I would like to ask about what that limit of distance would be at present? He might also answer what would be the limiting grade that it would be safe to build a railway on so that in the winter time, when there was ice on the rails, the car could be kept in control and there would be no danger of it being locked and taking the people down. Then there is another question. I have understood that the alternating current is out of the question now for running electric railways, that they cannot get motors that will start up quickly. One electrical engineer of very high standing and of long experience and very well posted in the theoretical part of the work, told me, some time ago, that that was out of the question.

Mr. Armstrong: Mr. President, I might speak of the matter of limiting grades first, which would allow of the operation, I presume, of both light freight and passenger service during the winter season. On a matter like that you can only speak really from experience. I might instance very forcibly in this connection the case of the Galt, Preston and Hespeler railway. There they handle, and did handle during last winter, their passenger service without any difficulty over grades of five, six and even seven per cent; they also handled a light electric locomotive freight service over the same grades without any difficulty at all. Even over the longest grade which they have, which rises from the town of Galt to the C.P.R. bridge, and which at places is as high as six and a half or seven per cent., they can haul a load of two freight cars. On the grade at Preston, at the end of the line, where the grade is about five per cent., they haul, ordinarily, one, and in some cases two, coal cars loaded to their full capacity up the grade. It seems that up to the point that we can keep a reasonably high voltage without excessive line loss that we can handle the freight, and unquestionably the passenger service over tracks laid generally on existing grades, with very slight cutting down.

Mr. Hopkins: Would it be necessary to have motors on every axle and brakes on every wheel?

Mr. Armstrong: I might go a little further into the freight locomotive question at Galt. The handling of passenger traffic is comparatively easy. The car used for freight purposes is mounted on a single truck and with two motors, one on each axle, of the G. E. 1200 type, wound with a four turn winding, and there has been no difficulty at all. When the car was first sent up it was found too light to carry two cars up the grade at Preston; the wheels would revolve and the cars run backwards. That was remedied by putting some three tons of pig iron on the floor. Since then they have had no difficulty, even in the winter. As to the question of the limit or range over which we may expect these radiating or radial lines to extend, it is a difficult question under present conditions, to give any definite limit. One can only examine existing cases and find out how far they can commercially operate with success.

Mr. Hopkins: I mean with one power house.

Mr. Armstrong: Taking the Hamilton, Grimsby & Beamsville road with one power house located, as it is in their case, in nearly the middle of the road, they have a limit of 18 or 20 miles; a transmission limit of 7 to 10 miles from the power house would be about the maximum with which economical results could be obtained without undue expenditure of copper. They do not handle any heavy freight; they just haul light cars behind their ordinary passenger cars. The Hamilton Radial Electric Railway Co. are now building a line from Hamilton to Burlington, and in their case the transmission limit will be eleven and a half miles from the power house. In that case they found it would be much more economical to invest money in copper to reach that distance than putting in polyphase apparatus. The cost of copper there is very considerable. The limiting distance would be ordinarily something under ten miles from the power house. In connection with the use of the alternating motor, I was pleased to find Mr. White Fraser draw attention to the road at Lugardo. I do not think there is any reason to doubt at all, that we will have in use in America a successful alternating railway motor which will give a reasonably high economy and in which the difficulties of control will be surmounted; and with the use of that motor our range of transmission will be increased and the limit to which radial lines can be extended will be very much greater than it is at present. I had the opportunity of seeing a car at Schenectady some time ago in which it was endeavored as far as possible to conform to the requirements of ordinary traffic; and while there were certainly some difficulties which in detail would have to be surmounted, there did not seem any liklihood that its success for practical purposes would be very long delayed ; at least, the engineers who are looking after the matter speak in the most favorable way of the results they are obtaining.

The Convention adjourned at 4.30 p.m., to meet again Friday morning at 10 o'clock.

THIRD DAY.

The President called the Convention to order at 10 o'clock.

The President : The first thing on the programme is the presentation of papers, the first being a paper by Mr. P. G. Gossler, of Montreal, entitled "Some Central Station Economies." (See page 15.)

Mr. Gossler, on rising to read his paper, said : It was stated in the minutes read the day before yesterday that I had been asked to present a paper on high potential underground systems. The present subject has been selected because I thought it would be of more general interest to the convention. I have been for several years connected with the operation of the subways of New York city, and have a collection of data which I shall be pleased to place at the disposal of anyone who is contemplating entering into underground work. I may say in regard to plates 4 and 5 that I regret those plates are not larger, because I am sure they will be appreciated by anyone who has made lamp tests. I have larger copies of these and will be glad to place them at the disposal of anyone who wishes them because they represent a very great deal of labor. The formula which I have included in this article here is one that has been found very useful.

The President : You have heard this paper read. The subject is now open for discussion. I know there are a number here who are anxious to ask questions. I hope the discussion will be full, but quick.

Mr. Breithaupt : Mr. President, the Association certainly ought to tender its thanks to Mr. Gossler for the excellent paper he has given us on Central Station Economies, in the reconstruction of an old central station. All of us who have had experience in central station working know that the central stations which were put in five, six or seven years ago are according to present methods very inefficient. Not only is this the case with some of the larger central stations of the older type, but true with the smaller stations ; that is probably a reason why so many of our smaller stations throughout the country prove very unremunerative to the people who own them. The reconstruction of the central station, particularly the small central station—I have had experience with a number of these—is a matter of considerable difficulty. You speak to the owners of plant ; they know that the plant is not remunerative ; they know that from actual experience. There are plenty in the country who have not made a dollar out of it. With the old apparatus they have increasing and very great induction loss, line losses and all that sort of thing. You tell them to put all this old apparatus on the scrap heap—that it is the best thing to do—and you will meet with great opposition. It is a hard thing to do, to reconstruct particularly a small plant, to bring it to a proper basis. Mr. Gossler's statements about the transformers are very interesting indeed and very instructive, and the lamp curves even more so. Plates 4 and 5 are, I think, of very great interest to all central station men. I would like to ask Mr. Gossler what efficiency of lamp is used in Montreal?

Mr. Gossler : The efficiency of the lamp, as I have stated, depends on local conditions ; there are some places where we can use a less efficient lamp than others. The lamp we mostly use is a 50-volt lamp, with a current consumption of 1.03 amperes.

Mr. Breithaupt : The formula Mr. Gossler gives here is also very instructive and one I think that is not generally known, and which will be of great interest to central station men.

Mr. Armstrong : The plant referred to in Mr. Gosser's paper is, I presume, that of the Royal Electric Co., of Montreal. I should like to ask Mr. Gossler, in considering this reconstruction, what is his reason for adopting the belt-driven generator?

Mr. Gossler : Mr. President, in regard to the adoption of the belt-driven generators, I would say that there are conditions under which the direct-driven dynamos are, of course, desirable. In the present case we were confined to the utilization of the engines we had in our station, which it was impossible to use in that way, if it had been so desired.

Mr. Wright : As far as that question of the direct-driven generators are concerned, there are other plants than direct-driven being installed at the present time. As to the question of belt-driven generators at the present time, as Mr. Gossler speaks of it, there are many reasons for the procedure. The question was not addressed to me exactly, but it might be in order to give one or two of the reasons. In the first place, you have an engine ; it must be of a reasonable sized unit ; it would necessarily be confined to that particular class of service. As an incandescent lighting load is a load that is at its maximum for a very few minutes during the day, comparatively to the rest of the 24 hours, you condemn your engine that is driving that large sized unit to idleness for 23½ hours, practically. By using a belt-driven generator an engine can be made to drive two, three or more generators for supplying different classes of service. Most stations, of course, are using currents of varying quality and it becomes necessary in a large city to do so ; and the same engine can be utilized for all purposes, to a certain extent. Again, a belt-driven generator, driven from the fly wheel of an engine direct, may be considered, for all practical purposes, as a direct-driven generator. You have the flexibility in the belt, which is an advantage ; there is also the question of the size of unit. This difficulty has often been found in using a very large direct-driven unit on an engine : there is always liability to accident by reason of any little inequality there might be in the bearings, or in bringing the poles too closely together where alternating machines have been driven direct on the shafts. All these questions have to be taken into the calculation in installing plants, whether direct driven or belt driven. You also have the advantage of running the engine at a slow speed, which all engineers will agree it is better to do if possible. As a rule, where you have direct-driven generators they are placed on the ends of the engine shafts, and that complicates, to a considerable extent, the engine itself ; it probably nearly doubles its cost ; it renders necessary the introduction of bell cranks. An engine with a straight shaft and overhanging disc and crank pin is simpler and more reliable. There are a number of reasons that would affect the question, a few of them I have given. I think there are many more.

Mr. Armstrong : I entirely agree with Mr. Wright that circumstances govern altogether the desirability of using the direct-connected or belt-driven generators. In this case I was considering the specific example which Mr. Gossler had put before us, of the re-construction of the station in Montreal in which were installed five 300 K.W. generators. But, of course, the governing circumstances of their using their present engines would be the main factor there.

Mr. Ashworth : I notice in one portion of Mr. Gossler's paper he states it is only in a densely populated city and in the more densely populated portions of that city, that it is practicable to use the secondary main system. From my own experience, and I think from the experience of a good many smaller station men, it is quite practicable to use secondary station distribution in much smaller places than Montreal, probably in places of two to three thousand inhabitants. I would like to ask Mr. Gossler if it is not economical to use secondary station distribution in smaller places.

Mr. Gossler : When I said smaller places, I had no reference to a large or a small city. My statement was intended to refer to where customers were bunched or scattered. With reference to the limitation of the secondary system—as I have stated in my paper the most economical side of the balance can be determined by such a method of reasoning as outlined in my paper.

Mr. Armstrong: There is another factor which I think should enter into that, and that is the generally higher efficiency of the larger transformer.

Mr. Gossler: That is included in the cost of maintenance of a transformer; in the cost of maintenance in a transformer the leakage current is included, consequently the higher "all-day efficiency" of a transformer the less the cost of maintenance the maintenance of a transformer really being the factor that would bear the greatest weight in determining the type of transformer to be used.

Mr. Milne: I would like to ask Mr. Gossler in regard to this: He says: "Apart from this increase in capacity, there is also the saving due to running a smaller engine for the day load, and the consequent saving in labor, oil, etc." When they shut down a smaller one and open up a larger one, does the saving of labor start at that point?

Mr. Gossler: That refers, not to a temporary decrease in one day of 135 amperes. If you decrease the station leakage load 135 amperes, it means a decrease in the load for every day of the year which will permit the operation of a smaller engine during the day, consequently decreasing the item of engineer's salary.

Mr. Milne: According to that, they have an engineer for each engine.

Mr. Gossler: In regard to having an engineer for each engine, the circumstances may be such that that is necessary. If the engines are large that may possibly be necessary; it depends on local conditions. It is not a general statement at all. The requirements of the services of engineers is entirely a local consideration.

Mr. Dion: I think Mr. Gossler has earned the thanks of this Association for the valuable paper which he has just read. It is a paper of very practical interest to central station men; a paper which I regret I did not get into my hands sooner. I did not see these papers until I got here, and since we got here there has been no time to read. I would have liked to have become more familiar with it, so as to be able to discuss it more intelligently. I think it is a paper that should be thoroughly discussed. However, I am not in a position to do it justice. There is one part of this paper I wish to refer to, where he speaks of the records made in order to calculate the changes necessary to improve the regulation of the line, &c. In order to obtain the required information he established a system of transformer maps, pole maps, etc. Last winter, through the courtesy of Mr. Gossler, this system was shown and explained to me, and I can assure you it is the most thorough system of keeping records that I have ever seen anywhere. I found it so good that I adopted some of the features in that system of keeping records, and had them carried out after I returned home. But I must say I did not adopt the system in its entirety. I found it unnecessarily complicated for a city like ours, however useful it may be in a larger place like Montreal. However, there are many valuable features in that system which I was very glad to learn and to put in practice afterwards. Reconstruction is a problem which confronts every central station manager It is no doubt, as many of you know, a very difficult thing to tackle, and there is a question of how far you should go on with this reconstruction. It is difficult to convince a board of directors that it is going to be a paying thing to scrap the whole station apparatus; but in many cases I suppose it would be well to do that rather than carry on the reconstruction by degrees. We are doing some reconstruction, but it is being carried on gradually. We have not scrapped any large amount of apparatus at any one time, but I suppose before we get through there may be a considerable amount put by. There is this to be considered, that in making a change before you are compelled to do it, you may save some money in making exchanges of generators. We have been able to obtain a very considerable allowance for old apparatus; and I am satisfied that if we had waited for two or three years more we would not have obtained anything for them. That is a great drawback, this reconstruction which becomes necessary in connection with electric lighting. A prominent banker in our city told me he found that to be the greatest obstacle in the way of electrical investments; that is, in the opinion of capitalists, an obstacle. Regarding transformers, our plan has been not to scrap transformers and buy a new outfit, but simply not to buy any more small transformers. Where required we put up large units, displacing a number of smaller ones which are useful to supply customers in the more scattered portions of the city; and in that way the more thickly populated part is supplied by large transformers and secondary mains; and we found that to be preferable in our case than scrapping transformers in a wholesale way. I have one word to say in reference to the over-running of lamps. I quite agree with Mr. Gossler that it is not a practice to be recommended. In our city we made that mistake. It was brought about by a keen competition between companies and a desire to have our lights better than the others, and we got into the habit of running our lamps over the normal voltage, consequently it was found afterwards very difficult to reduce that. We had got into difficulty, the lamp consumption had become very large, and we found it necessary to stop this practice. I had read that the same difficulty had been met in other cities by a gradual reduction of the voltage, say half a volt every night; but we did not care to do it in that way. I could foresee a lot of trouble. We preferred to re-model the circuits for better regulation, and drop the voltage in one night, changing the lamps on that circuit during the day. It takes a horse and wagon and several men to do it, and it costs a good deal, but we thought that was a better way of doing it than to gradually lessen the voltage and allow complaints to come in. I would like to ask Mr. Gossler—he has been asked a good many questions, but seems good-natured about it—as to the means taken to overcome the induction between lines. We have had some difficulty in that way and we have taken some means to overcome it, and I would like to know whether he has taken the same means.

Mr. Gossler: The means that were taken were very simple and very well known. The local conditions were somewhat peculiar: we had three very large engines and three principal routes. It was found, due to mutual induction, unless all the circuits on one pole line were run from one set of dynamos there was a decided fluctuation; unless we ran each pole line on a separate engine, we were not given credit for knowing much about lighting. To overcome this inductive effect, the feeders were re-arranged, by simply bringing opposite polarities as near each other as the pins on the cross arm would permit. When the lines had to be reconstructed it was found that one leg of the circuit was on one end of the cross arm, while the other leg of the same circuit was on the extreme end of the same cross arm, so that the worse inductive effect possible was obtained. We did not go to the trouble of crossing the circuits as is customary in long transmission, because we found that it was unnecessary. We reconstructed, first, one or two circuits, bringing the feeders close together so that the mutual induction due to the other circuits was practically the same on both legs. After one or two circuits had been reconstructed, we foun d it unnecessary to cross the circuits, but simply proceeded on the line of bringing the feeders close together, which has given perfectly satisfactory results. We have some twenty odd incandescent circuits, all heavy, and we find we can run one or two, or any number we please, on the same pole line from different engines.

Mr. Dion: That was exactly the conditions prevailing in our city. The circuits had been hung on opposite ends of the cross-arms for the purpose, as stated by the line foreman, of making the lines less dangerous. He said they had only one side of each circuit to work at, at one time, and there was a space in the centre which protected them from the other side. The men set up the plea that we were going to make their work much more dangerous, but when I explained to them that, the circuits being sometimes bunched on one no certainty, that two adjacent wires did not represent different terminals of one machine, they saw that they were just as secure after the change than before.

Mr. Wright: This reconstruction business is a very difficult matter, and there is a case in point that occurs to me where I think the difficulty will be emphasized. The electric light company in Hamilton are just about appointing a manager, and it would become the first duty of that manager to recommend the Board of Directors to throw out the whole plant. From what I know of the Hamilton Board of Directors, I think they are a great deal more likely to throw out the manager. It will become a question of scrapping the plant or scrapping with the manager. Mr. Gossler is so very well posted on these subjects that I think it is a first-class opportunity to pump him a little further and see if we cannot pump him dry. There are two important questions that come up not only in reconstruction, but also in construction: one is the frequency to use in the introduction of an alternating system and another is the voltage; those are questions that a little fuller information would be very acceptable on. Authorities differ on both questions. Whether it is better to adhere to the old style of sixteen thousand alternations or thereabouts or the more modern in the neighborhood of seven or eight, and if Mr. Gossler has any reasons and would go more fully into them for the change of voltage from one to two thousand, the information would certainly be very acceptable to us.

Mr. Gossler: In regard to the change of voltage from one to two thousand, we have drops on our circuits varying from one to ten per cent.; the regulation, of course, corresponds. Increasing the voltage to 2,000 volts will decrease the drop one quarter of what it is at present; there is no practical hindrance to the use of two thousand volts—it can be handled about as readily as one thousand—also modern transformers are made interchangeable, so they can be used on either one or two thousand volts. If you are going to increase the saving and improve the regulation by the adoption of the two thousand volts without any practical inconvenience, there seems to me every reason in the world why it should be done. It was decided in our case to use two thousand volts, principally for the purpose of getting better regulation with the present feeders; we do not anticipate any trouble. The two thousand volts is in operation in many places. There may possibly be a little difficulty with the lines that are now in contact with trees, as we now have some little difficulty in wet weather at the places with one thousand volts, and two thousand volts would be a little more troublesome, but these conditions will be changed at any rate. In regard to the question of frequency, that is a question that has to be decided by the local conditions. If the lighting is of paramount importance or the principal feature of the station, there is no question but that sixteen thousand alternations should be used. It is practicable to operate motors from sixteen thousand alternations as well as eight thousand. The leakage of the transformers does not decrease exactly inversely as the alternations, but approximately so, so that the leakage of transformers at eight thousand alternations is probably twice as much as sixteen thousand, and where the lighting load is the principal feature the sixteen thousand alternations is very desirable for this reason. If the plant is to be supplied by power from quite a distance, where it is necessary to transmit power from fifteen, twenty-five or thirty miles, induction comes in as a factor to be considered, and in most long transmission plants the lower alternations have been adopted. But, as I have said before, where lighting is the principal feature, there is no question about sixteen thousand alternations, especially as motors can be as readily used on sixteen thousand as on eight thousand, so that sixteen thousand alternations permits of serving light and power from the same generators.

Mr. Breithaupt: I have great pleasure in moving a hearty vote of thanks to Mr. Gossler for his very valuable paper.

Mr. Dion: I second that.

The President: It has been moved by Mr. Breithaupt, seconded by Mr. Dion, that the hearty thanks of this Association be tendered Mr. Gossler for his valuable paper. Is this your wish?

The motion was carried amid applause.

The President: I think the Association is to be congratulated upon the fact that we have men capable of giving us such a paper as Mr. Gossler has given us. The next thing on the list is the paper entitled "Power Transmission by Polyphase E.M.F.'s," by Mr. George White-Fraser. (See page 142).

Mr. Fraser, on rising to read his paper, was greeted with applause.

The President: We have not heard Professor Rosebrugh's voice in Convention; I think the members here would like to hear if he has anything to say on this paper.

Mr. Rosebrugh: Mr. President, I have not had time to look over the paper at all, and any remarks that I might make might be premature. Without further consideration I would not care to say anything.

Mr. Breithaupt: I would like to ask Mr. Fraser about the figures he gives as to the Lauffen-Frankfort transmission, as to where he gets them.

Mr. Fraser: From the official report published by Dr. Boaber, who was chairman of the official committee.

Mr. Milne: Has not Mr. Fraser drawn the arrows in diagram 12 in the wrong way? It occurs to me that the arrows are in front of the E.M.F.

Mr. Fraser: You will find the maximum E.M.F. is quite a distance from the mouth of the current.

Mr. Armstrong: If there is not likely to be any further discussion, I have pleasure in moving a vote of thanks to Mr. Fraser for his paper on this subject; it seems to have covered the whole field very fully on the subject of polyphase currents.

Mr. Wyse: I second the motion.

The President put the motion, which was carried.

Mr. Dion: I would like to call attention to two points in connection with this paper. One of the two features which give the paper particular value is the great clearness with which the phenomena of alternating currents are explained. As stated by Mr. Fraser, most of the statements on this subject are so surrounded by clouds that it is difficult for any but the advanced student to properly understand them. In this particular case he has explained the action of the polyphase currents in such a clear manner that he has no doubt helped to increase the knowledge of many members present. The other feature which I think deserves particular attention is his plea for good engineering, and I hope to see the day when his advice will be followed, and when every particular installation will be designed according to the local conditions, and when every installation, whether large or small, will not be undertaken before consulting competent electrical engineers.

Mr. Fraser: I thank the members and I thank Mr. Dion for considering these points.

Mr. Gossler: There is one point in the description of the generation of multiphase currents, as described in diagrams 3 and 4, which I think is probably an oversight on the part of Mr. Fraser. He states at the bottom directly under diagram four, "A,B, are two coils of the armature. The angular distance of A, B is half that of N, S. When A is right under N it is generating its maximum E.M.F.; at that moment B is half way between N, S and its induction, and therefore its E.M.F. is least." I call attention particularly to this statement inasmuch as it is very important. Mr. Fraser states further, "As the armature revolves clockwise, B gradually gets into a stronger field, while A is approaching a weaker one." Mr. Fraser states there that when A is right under N it is generating its maximum electro-motive force, which is the actual condition if the armature coils are so placed as in diagram 4. While diagrams 3 and 4 have been taken as general illustrations, I think it has been an oversight on Mr. White-Fraser's part, as this illustration can only apply to two-phase generation. If the coils are so placed that B is half way between N, S, it must necessarily mean the generation of two-phase currents 90° apart. It would alter diagram 3 to such an extent that the minimum point of curve 2 would be directly under the maximum point of curve 1, which is the condition of multiphase currents of ninety degrees apart. I think this illustration will only apply to the generation of currents ninety degrees apart.

Mr. Fraser: If you take diagram 3 in connection with diagram 4, your idea is correct. It is not a quantitative so much as a qualitative diagram.

Mr. Gossler: It is a trifle misleading if you combine diagrams 3 and 4, because it is not a general case.

Mr. Fraser: I have not specified any particular case. I think it is understood to be purely qualitative

Mr. Gossler: There is another point in regard to the position of the armature coils which this illustration can be made to show most beautifully the re-action and inter-action of the coils on the armature, due to their relative positions, as affecting regulation. The regulation question is a very serious one and a very important one, and inasmuch as the diagram shows it so beautifully I thought possibly it would not be out of place to bring it to your attention. If the coils as placed in diagram 4, and as stated, when A is directly under N it is generating its maximum electromotive force, and B being half way between N, S, the electromotive force is minimum, then when the current in A is maximum there can be no current in B, consequently there can be no induction from B to A. The effect on one side of the coil B from A is the same as on the other side, they being symetrical to coil A, so that the two conditions taken together show the impossibility of any action between the two phases; the practical demonstration of the fact of their being no influence on regulation from one phase to the other in two-phase generators is borne out by every day practice. If we pass further on from two-phase apparatus to multiphase apparatus, Mr. Fraser mentions the possibility of placing three or four or any number of coils in a similar space, but the four coils are of no practical use. If we consider the space between N, S, divided into three spaces so that we have three coils placed there, we have a generator generating three-phase currents. If we divide that space so that it is divided into three and apply the same reasoning as above, the coils not being symetrically or relatively inductively placed to each other, there is but one condition in a three-phase generator in which the mutual induction or re-action of the armature coils is equal, and that is when the coils or phases are equally loaded. When they are not, on account of this re-action of the armature coil, one coil of the armature acts as the primary of a transformer, while the other two coils act as the secondaries of a transformer. When the phases of a three-phase apparatus are not equally loaded there is a transformer action which necessarily boosts up one side of the circuit and decreases the voltage on the others.

Mr. Fraser: I have been very careful to avoid any comparison of the two methods.

The President: We will now have Mr. E. J. Phillip's paper entitled "Operating Engines without a Natural Supply of Condensing Water, or the Continous Use of Injection Water." I am sorry Mr. Phillip is not here, but Mr. Wickens will read his paper.

Mr. Wickens: I regret Mr. Phillip is not here to read this paper himself. He has given some considerable time and study to this particular arrangement, and hopes to install a considerable plant under this style. I really regret that he is not here to read this paper himself, because should any discussion occur, he would be very much more capable of taking up the points than I will. There is another thing that I would call the attention of the members to before reading this paper, and more especially to those of us who have been attending the conventions straight along, and that is as to the scope of the papers that have been read. There is no question in my mind that the papers read at this Convention have been somewhat an advance on any of the others, and of course in an Association whose scope is so great and which reaches out so far as this, the papers must necessarily cover a very large ground; and while, it seems to me, in a measure the interests of the larger establishments have been held forth, the interests of a very large number of the smaller plants throughout Canada have been taken into account. The other day, in conversation with a gentleman who had travelled largely in England and also largely in Canada, he said that one of the first things that attracted the attention of an Englishman in Canada was the fact that the small hamlets were lit up with electricity. That means that we have a large number of small plants scattered throughout Canada, and we should have a large number of the proprietors of those small plants attending our Convention; and I honestly hope the members that are here to-day and the incoming Executive will make a special movement to get a large attendance of that kind next year.

Mr. Wright offered the use of his steam yacht for a sail on the lake at three o'clock.

The President: Mr. Wright has a very handsome steam launch, and if any of you can make it convenient to go you will find it very pleasant.

Mr. Wickens: The title of this paper is "Operating Engines without a Natural Supply of Condensing Water, or the Continuous Use of Injection Water." (See page 152.) This is coming to be very vital as far as the steam end of electrical plant is concerned.

The reading of the paper was greeted with applause.

Mr. Wright: I am sure the Association is indebted to Mr. Phillip for the getting up of this paper. The subject, it seems to me, is far too important a one to bring in and discuss at this late stage of the proceedings of the Convention, and I would like to suggest that a request be made to Mr. Phillip by the Association or the Executive Committee to amplify this paper and bring it before us again at our next Convention, when I think we shall have more time to discuss it and do it the justice that its importance demands.

Mr. Wickens: There is one thing I would like to call the attention of the members to. Mr. Phillip, unfortunately, is not a member of this Association, although he has intimated his intention of becoming a member, but for some reason or other he did not get his application in, and I would like to have the secretary forward him a vote of thanks from this Association. He is one of our bright young men in the city of Toronto.

Mr. Armstrong: I should like to move a vote of censure to Mr. Wickens for not seeing that Mr. Phillip was a member of the Association. However, I will withdraw it.

Mr. Wickens: We put the proposition in, but for some reason or other it was skipped.

Mr. Hopkins: The H., G. & B. Railway have adopted something like this. They had a great deal of trouble deciding where they would locate their power house. I understand they never had a proper inspection made previously to locating their power house, to find whether they could get water there or not. They had the power house built and then tried to get water for condensing their engine, and then afterwards they found they could not very well get it. They dug down a deep hole through very sticky clay, which was a very expensive operation, and this seemed to answer the purpose very well; but this big hole was filled by water coming down from a creek and this was very muddy in the spring of the year. They found that the water would run down very fast and freely soak into this clay, with the result that it would not be full enough to supply them, so they put a pipe low down, I think about a foot or something like that in diameter, to connect the bottom of this creek with this hole. The result was that the water going in was very, very dirty, and full of grit and sand; then, in midsummer this place dried up completely and they were without condensing water, and in fact, without any water at all. They hauled water for a while with a team for their boilers, and the finally, when they got tired of that, rented the power from Hamilton and had the water transferred down seventeen miles. That is one example of this. They used the water in such a way that it would cool itself afterwards by running out in a trough and then running down. This trough was leaky and let the water escape and cooled it very well. After they found that the hole wouldn't supply water in the summer time, and as they didn't want to rent power from the Hamilton Street Railway Company again, they dug a deep well, and when they dug that they found out that the water was all full of limestone and calcium sulphate, and it did a great deal of harm. I mention this to show that in many cases it would be very well, but here is a case where it did not work very well, but it is better than if they didn't have it.

Mr. Ashworth: I might say a few words which would possibly be of interest to Mr. Phillip when he comes to amplify the paper, which has just been suggested. The first thing I notice in his paper which attracted my attention, was the proposed cost of condensing apparatus, which is set down at $300. Personally, I know from having bought one or two condensers that it is impossible to get a condenser for a plant of one hundred horse power for anything like $300. I think it would be low enough if we say $600. Another thing is, that in his calculations he does not allow anything for the immense cost of pumping water from the top of high buildings, which one would imagine would be certainly considerable. However, that is something which he may further explain in his paper. I personally have been connected with a plant which is using water for condensing purposes in a town out west, and in that town we had no means of getting water at all. We had a spot which was supposed to have water underneath it and we found out it hadn't any.

A voice: What had it?

Mr. Ashworth: Principally oil. Oil is not very good for cleaning boilers. As luck would have it, behind this place there happened to be a large number of underground tanks, and we conceived the idea of using the water from these underground tanks, which contained probably about 20,000 barrels of water. We pumped the water from the nearest of these tanks and discharged it into the farthest, some 300 feet away, by means of a long low trough in which there were a number of cleats with sawed edges, which apparently distributes the water very well, and we get the water at a comparatively low temperature; in fact we experience a great saving by it, and we find instead of having to buy water, as we did in the summer time, we get enough water from these small wells we have, and it has greatly diminished the expense in almost every particular. Of course, the original installing expense is considerable. This makes me think that if any scheme could be devised for obtaining this, I think it would be a very good thing. It would be of interest to central station men throughout the country if Mr. Phillip would, as has been suggested, amplify his paper and present it at some future Convention..

Mr. Wickens: I understood he got the figures from one of the steam pump makers, and they are the figures he gave him. We have in his city a large institution, and they have for several years run upon the principle of using the water over and over again from a set of tanks. The difficulty in that case was the expense of putting in all these tanks and the ground occupied. The slowness by which the water cooled made the investment too great for an ordinary small plant such as Mr. Phillips has attempted to represent in his paper. The fact of being able to run your water in such a way as would cool it in any ordinary tank, makes it necessary to have very many more times the quantity of water to do your cooling than you actually need. In this case represented in the paper you only require the actual quantity of water you are pumping in your pipe to evaporate your steam. The air is the cooling medium and not the water. As in the case referred to by my friend, it is not calculated that the water is the cooling medium. The water is only a means to an end.

The President: The suggestion by Mr. Wright that we have this paper over again at Niagara Falls at our next Convention, is a very wise one. By the kindness of Mr. Dunstan, of the Bell Telephone Company, I am permitted to say that any of the individual members (we can hardly go in a body) who care to visit the Bell Telepone Company's exchange and inspect the switch board and the operating room and so on, the company will be pleased to see them at any time.

Mr. Dunstan: Unfortunately for myself, and unavoidably so, I was not present at the session yesterday when the election of officers took place, and the members of the executive were elected. On looking over the lists I cannot but feel great regret that the City of Ottawa is not represented. I am sure that that has occurred simply by some unfortunate oversight in not presenting to the meeting the name of the Ottawa members. Remembering, as I am sure we will, the splendid work of our Ottawa friends last year and the brilliant results which they accomplished, I cannot help but feel, as I said before, great regret that the omission occurs. I am sure I can say this without it being understood in any way as a reflection upon any of those who were yesterday elected to the positions, and I would myself be only too willing to resign my position on the Executive if it could be filled by some Ottawa member. I am sure, as I said before, it can only have been by some oversight in submitting the names to the meeting that the omission took place, and I would not, for a great deal, that the impression should go abroad that we had in any way forgotten the efforts which were made on behalf of the Association in Ottawa last year, or that the impression left on our minds then had been obliterated by intervening time.

Mr. Dion. As a representative from Ottawa I may say that I was a little disappointed yesterday when I found that no representative from our city had been elected to any position on the Executive Committee. Not that I personally wished the honor—there were other candidates besides myself nominated from Ottawa —but I do not like the idea of going back to Ottawa and give the impression that the presence of the delegates who are here now has had the effect of reducing the representation of three last year to zero this year. I am very thankful to Mr. Dunstan for his thoughtfulness in mentioning this matter. I do not cast any blame on anyone. I suppose it is difficult to arrange the representation so that there will be representatives from each centre. There are many other considerations, no doubt. However, I am very thankful for the reference.

Mr. Wright: The difficulty appears to be that the election of the Executive Committee is made at large. If we had certain representatives from each district we would have no difficulty, but it is owing to the plentitude of good material that the omission seems to have occurred. I deplore just as much as anybody that we have no representative from the city of Ottawa. It is easy to see how it has occurred. It is in balloting for the members, which, you may say, is almost a matter of chance, in a way. I would not like to see any member who was elected yesterday by the Association resign his position. That, it seems to me, would be out of place. But I am certain if any way can be suggested by which a representative can be obtained from Ottawa, it would be well.

Mr. Black: I think we were led into trouble by the previous elections. I noticed when we were electing the principal officers, the President and two Vice-Presidents were all out-of-town members, and the Secretary was the only officer residing in Toronto, where the headquarters of the Association is. On the other hand, it was desirable to bring in a gentleman from Niagara Falls, and a gentleman from further west, and the impression seemed to get abroad then with the members that it would be desirable to have the executive members, if not in Toronto, very close to Toronto. I know this year our Executive has been very scattered and we have had difficulties in getting a quorum. Mr. Breithaupt and myself have come to Toronto every time when an Executive meeting was required. I think that some of the meetings had to be postponed on account of the members not attending, and I think that is how the matter has been brought about. As one of the scrutineers, I may say that the elections were all very close; they ran almost neck to neck, with very few exceptions, so that there was nothing personal to anybody. But I was about to suggest, as I have been on for several years, if there is a sufficient number to make a quorum without meeting, that one of the gentlemen should be elected before we adjourn, to show our good feelings towards them. They stood right royally by us last year.

Mr. Armstrong: I think there is no doubt at all that the reason there is no representative elected from Ottawa lies in the fact that there were three gentlemen from Ottawa nominated: it was not the feeling that Ottawa should not be represented, but the votes were scattered amongst three.

Mr. Dunstan: I think there is no doubt that it was an accident pure and simple, and that it is regretted by the members of this Association, and I believe that the Ottawa members will understand it in that way. I think Mr. Armstrong's suggestion is the correct one. As I said before, I was not personally present, but I think that probably the vote was simply split, and the elections, as Mr. Black stated, being close, the result of this little scattering simply resulted, unfortunately, in not any one of the three being elected from Ottawa. Mr. Black has stated that he would like to resign. The difficulty of the position is not so much in resigning, but possibly in getting an Ottawa gentleman to accept the position if a nomination was made. If I felt sure that a nomination would be accepted on those premises, I would at once place myself as resigning. I therefore hesitated to press that very strongly. If any vacancy should occur during the year, there is no doubt it will rest with the Executive Committee to fill that vacancy, and I think you will find that it will go to Ottawa.

Mr. Hunt: Is there anything in our Constitution by which we can increase that number? If there is, I would like to make a motion to that effect.

The President: The Constitution distinctly states that the Executive shall consist of ten members.

Mr. Dunstan: It cannot even be changed on the same day, because no change of the Constitution can take place on the day on which a motion is introduced, and as this is the last day of our session, we can't make a change; otherwise I would have made a motion on the same line as Mr. Hunt's suggestion.

Mr. Dion: I am very thankful to the gentlemen who have offered to sacrifice themselves for the satisfaction of the Ottawa members, but I do not think we can avail ourselves of any such offer as that. I think we may let the matter drop. There is one thing I would like to mention while the subject is up, and it is this: Mr. Black spoke as if there was a feeling that owing to several of the officers being non-resident of Toronto, a certain number of the Executive should be Toronto men on account of the convenience there would be in getting them together during the year. There must be great difficulties in getting meetings and in doing business, when the Executive is scattered all over the country, but that is a difficulty which exists in all associations of this kind. There is no way out of it, except to elect members from one city all the time, that is, where the Association has its headquarters. This would be sure to bring dissatisfaction and it is hardly practicable, therefore the only other way seems to be to let the Executive be scattered and make the best of it. If it is to be scattered, I think it ought to be well scattered, because there is this view of it, that every member of the Executive Committee is an active member of the Association in his own district, and I think in scattering the members throughout the important centres, the Association might probably be benefited. I merely speak of it as a matter of general policy for the Association.

Mr. Armstrong: I think the whole difficulty in connection with this is on account of our present mode of election, which practically restricts us. It means the continuance in office of five members of the existing board, and it limits the choice to that extent. I think it would be probably better to have an election of five members annually to hold office for two years. I think the present mode of election accounts for such a result as we had yesterday.

Mr. Breithaupt: I think the suggestion of Mr. Armstrong in relation to the changing of the Constitution is very timely. Yesterday I raised the question as to how the election ought to proceed, because I was under the impression that it had to proceed that way. Now the thing is somewhat mixed up, and we all got a little confused in the election. As Mr. Dion has said, I think it would be a very wise plan to have the members of the Executive chosen from different parts of the country, as much as possible, so as to create an interest, and we would have live agents all over to advocate our cause.

Mr. Fraser: I think we can divide it up in sections and make this Association more of a national character: for instance, in West Ontario and Toronto and Montreal, and in Ottawa whatever sections are decided upon. I think the representation would be better, and the interest in the Association much better, by having responsible agents, so to speak, or Executive officers, in various parts of the country. I think it would greatly widen the scope of the Association, and everybody would take a great deal more interest in it than they do now when the people seem to think it is purely an Ontario Association.

Mr Wickens: As a member who assisted in revising this Constitution, I may say that the committee took considerable pains to adopt what they considered the best plan on which to arrange and elect their Executive board. It was felt at that time that it was really in the interests of this Association that there should be some members continually on the board, for which reason the present plan was chosen and a report made at the last Convention, and it was unanimously adopted at that time.

Mr. Wright: I rise to a point of order. It is entirely out of order to have this discussion on the Constitution, and no resolution or notice of resolution before the Convention.

The President: Mr. Wright is quite right.

Mr. Dunstan: I wish to move that the President vacate the chair for a few moments and that Mr Breithaupt act as chairman.

Mr. Breithaupt took the chair.

Mr. Dunstan: I move that a hearty vote of thanks be tendered to Mr. Smith, the retiring President, for the very able and efficient manner in which he has performed the duties of his office during the past year, and for the capable manner in which he has presided over the various sessions of this Convention. If the day were not so hot and time were not so pressing, there is much that I could say to you about the splendid work that Mr. Smith has done for this Association, both before he was elected to the Presidency and during the time he has acted in that capacity; and, if I may anticipate a little, what he will do in the future. But that is all apparent to you as it is to me; it is fully realized by every member of this Association. I think I will content myself by moving a very hearty vote of thanks to Mr. Smith, and I am sure that the motion will receive your hearty support and approbation.

Mr. Black: I have great pleasure in seconding the motion.

Mr. Breithaupt: It has been moved by Mr. Dunstan, seconded by Mr. Black, that the services rendered by Mr. A. B. Smith during the past year, and the services he has rendered the Association throughout, be recognized by passing him a hearty vote of thanks, and I will ask all who are in favor of the motion to signify by a rising vote.

The members of the Convention arose in a body to their feet and the motion was carried with applause.

The President: Gentlemen, I simply wish to thank you. I know you mean it, and I am sorry that the man who preceded me in office as President did not bequeath to me his eloquence. I assumed the office with fear and trembling, and conscious of my inability; yet, I was willing to do the best I could to further the interests of this Association. (Applause.)

Mr. Breithaupt: Before we adjourn I think we should pass a vote of thanks to Mr. Milne for giving us the very instructive and interesting lecture on "Radiant Matter" which we had on the evening of the first day of the Convention. The lecture was certainly very instructive and of very great interest, and particularly so at the present time.

Mr. Hunt: I have much pleasure in seconding the motion. I enjoyed the lecture very much.

The President put the motion, which on a vote being taken was carried.

Mr. Wright. I have great pleasure in proposing that the thanks of the Association be given to our Secretary for his painstaking and conscientious work during the past year.

Mr. Armstrong: I second that.

The President: Everybody in the room ought to second that.

The motion was carried unanimously.

Mr. Mortimer: I cannot but feel that the work I have tried to do is appreciated, and if it is not as good as I have tried to make it, it cannot be helped.

It was moved by Mr. Dunstan, seconded by Mr. Fraser, that the thanks of the Association be tendered to the Toronto Electric Light Co. and the Toronto Railway Co. for having permitted an inspection of their power stations by the members and friends of the Association.—Carried.

Mr. Wickens: I move a vote of thanks to the management of the Board of Trade building for the very comfortable quarters we have enjoyed and the very courteous treatment we have received during the time we have had our Convention in this building.

Mr. Armstrong: I second that.

The motion was carried unanimously.

Mr. Armstrong: I have much pleasure in moving a vote of thanks to be tendered to the press of Toronto for the good reports that have appeared in their issues. I have no doubt that the pressure of political matter has interfered with the giving of fuller reports of our proceedings.

Mr. Black: I second that.

The President put the motion, which was carried.

The President: I think, gentlemen, that is all. I wish to thank you very sincerely for your close attention. The Convention has been a success from the point of attendance and also the interest taken in the papers, and it augurs well for future Conventions. Personally, I feel sorry that Ottawa has been omitted from our list of the Executive. I did not want to refer to it, but several spoke of it yesterday, and the speakers were all Toronto men. It was an unintentional accident. I declare the Convention adjourned.

EXCURSIONS AND BANQUET.

Upwards of one hundred members and guests of the Association proceeded to Lorne Park per steamer "Greyhound" on Thursday evening and participated in the annual banquet at the Hotel Louise, returning to the city about midnight. A very pleasing feature of the return trip was the presentation by Mr. Higman, on behalf of members of the Association, of a gold-headed cane to Mr. A. B. Smith, the retiring President.

On Friday afternoon an enjoyable time was spent by a number of the members and their friends on board the steam yacht "Electra," by kind invitation of the owner, Mr. J. J. Wright.

MR. JOHN YULE.

The honor of becoming President of the Canadian Electrical Association was, at the recent convention, bestowed upon Mr. John Yule, of Guelph, whose portrait appears on this page. Previous to coming to Canada Mr. Yule was for ten years connected with the Dundee Gas Company, of Dundee, Scotland, and for two years with the Dundee Municipal Gas Works. Shortly after coming to Canada, over twenty-five years ago, he assumed the management of the Guelph Gas Company, which position he still holds, the name of the company having since been changed to the Guelph Light & Power Company. During this extended term under the direction of Mr. Yule, the company has attained a marked degree of prosperity. He is said to enjoy the entire confidence of the directorate and shareholders of the company, and the respect of the citizens generally.

The newly-elected president has been prominently connected with the Canadian Electrical Association since its inauguration. He was one of the committee appointed to formulate a scheme of organization in 1891, and was elected a member of the Executive Committee upon the formation of the Association, serving as such until September of last year. He is deeply interested in the advancement of electrical industries, and it is safe to say that the affairs of the Canadian Electrical Association will be ably conducted under his direction.


MR. JOHN YULE,
President-elect Canadian Electrical Association.

AN INTERESTING LEGAL SUIT.

The decision in the case of the Bell Telephone Company vs. the Montreal Street Railway Company, which was given last week, is of much interest to electric railway and telephone companies.

The Bell Telephone Company entered suit against the Montreal Street Railway Company, claiming $30,000 damages, on the ground that the introduction of the electric trolley car system into Montreal in 1892 caused, and has been causing ever since, a serious disarrangement of the telephone service, and necessitated the adoption of a number of expensive contrivances to counteract the effect of the presence of the trolley wires, with their attachments, which would otherwise have caused the diversion of currents running along the telephone wires, the area adjacent to the trolley poles being always charged with electricity, which naturally would have impaired the efficiency of the telephone service, if the Bell Company had not gone to considerable extra expense. For this extra expense it is now claimed to be indemnified as above, up to the date of the entering of the action with reserve of claims for further subsequent damage.

The Street Railway Company's main plea was to the effect that, in establishing the trolley system, it had acted within the rights granted it under its charter with the city of Montreal, and that it could not be held liable for any damage incidentally suffered by the Bell Telephone Company.

The hearing of the case was commenced in the spring of last year, and occupied ten days, during which a great deal of technical evidence was heard.

Judge Davidson last week gave judgment, dismissing the action of the Bell Telephone Company.

DEATH OF MR. EDWARD LUSHER.

Mr. Edward Lusher, secretary-treasurer of the Montreal Street Railway Company, died on the 11th of June, at the advanced age of 71 years. The deceased had for upwards of fifty years been prominent in business circles, and was probably the oldest railway man in Montreal. For eighteen years he filled the position of secretary and general manager of the old horse car system. Upon the reorganization of that enterprise three years ago, Mr. Lusher took the position of secretary-treasurer, which he has held up to the present time In 1885 he was elected a vice-president of the American Street Railway Association, and it was mainly through his endeavors at the convention in Milwaukee in 1893 that the session was held in Montreal last October.

The history of street railroading in Montreal from its very inception many years ago, was really a portion of the life-history of Mr. Lusher. He saw the Transportation Company in Montreal grow from a couple of miles of track on Notre Dame street, with its homely old cars and crude track, into the extensive system of to-day. For a man of his years Mr. Lusher was wonderfully well preserved, and looked and acted many years younger than he really was. In his death the company lose a valued and faithful servant.

Advantages of Electric Light in Bad Air in Mining.—The results of some recent experiments of Dr. Haldane have been made public. They refer to the presence of black damp; he finds that when the percentage of oxygen has fallen to 17.64 a candle is extinguished; at 3.38 per cent. of carbonic acid gas, and 15.3 per cent. of carbonic oxygen his respiration began to deepen, and at 7.32 and 9.62 per cent. respectively there was violent panting; at 7 per cent. of oxygen consciousness would probably have been lost. He thus shows that there is a wide margin between the point of the extinguishing of a lamp and the point of danger to life; a miner provided with an electric lamp could therefore penetrate with impunity or escape through atmophere containing at least three times as much black damp as would extinguish a lamp and the difficulty of respiration would give ample warning if the electric lamp did not.

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Correspondence is invited upon all topics legitimately coming within the scope of this journal.

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CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

President, W. G. BLACKGROVE,	54 Widmer St., Toronto, Ont.
Vice-President, JAMES DEVLIN,	Kingston, Ont.
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Conductor, W. F. CHAPMAN,	Brockville, Ont.
Door Keeper, F. G. JOHNSTON,	Ottawa, Ont.

TORONTO BRANCH NO. 1.—Meets 1st and 3rd Wednesday each month in Engineers' Hall, 61 Victoria street. John Fox, President; Chas. Moseley, Vice-President; T. Eversfield, Recording Secretary, University Crescent.

MONTREAL BRANCH NO. 1.—Meets 1st and 3rd Thursday each month, in Engineers Hall, Craig street. President, John Murphy; 1st Vice-President, J. E. Huntington; 2nd Vice-President, Wm. Smyth; Secretary, B. Archibald York; Treasurer, Peter McNaugton.

ST. LAURENT BRANCH NO. 2.—Meets every Monday evening at 43 Bonsecours street, Montreal. R. Drouin, President; Alfred Latour, Secretary, 306 Delisle street, St. Cunegonde.

BRANDON, MAN., BRANCH NO. 1.—Meets 1st and 3rd Friday each month, in City Hall. A. R. Crawford, President; Arthur Fleming, Secretary.

HAMILTON BRANCH NO. 2.—Meets 1st and 3rd Friday each month in Maccabees Hall. Wm. Norris, President; E. Teeter, Vice-President; Jas. Ironsides, Corresponding Secretary.

STRATFORD BRANCH NO. 3.—John Hoy, President; Samuel H. Weir, Secretary.

BRANTFORD BRANCH NO. 4.—Meets 2nd and 4th Friday each month. F. Lane, President; T. Pilgrim, Vice-President; Joseph Ogle, Secretary, Brantford Cordage Co.

LONDON BRANCH NO. 5.—Meets once a month in the Huron and Erie Loan Savings Co.'s block. Robert Simmie, President; E. Kidner, Vice-President; Wm. Meaden, Secretary Treasurer, 533 Richmond street.

GUELPH BRANCH NO. 6.—Meets 1st and 3rd Wednesday each month at 7.30 p.m. H. Geary, President; Thos. Anderson, Vice-President; H. Flewelling, Rec.-Secretary; P. Ryan, Fin.-Secretary; Treasurer, C. F. Jordan.

OTTAWA BRANCH NO. 7.—Meet every second and fourth Saturday in each month, in Borbridge's hall, Rideau streett; Frank Robert, President; F. Merrill, Secretary, 352 Wellington street.

DRESDEN BRANCH NO. 8.—Meets 1st and Thursday in each month. Thos. Steeper, Secretary.

BERLIN BRANCH NO. 9.—Meets 2nd and 4th Saturday each month at 8 p.m. J. R. Utley, President; G. Steinmetz, Vice-President; Secretary and Treasurer, W. J. Rhodes, Berlin, Ont.

KINGSTON BRANCH NO. 10.—Meets 1st and 3rd Tuesday in each month in Fraser Hall, King street, at 8 p.m. President, S. Donnelly; Vice-President, Henry Hopkins; Secretary, J. W. Tandvin.

WINNIPEG BRANCH NO. 11.—President, G. M. Hazlett; Rec.-Secretary, J. Sutherland; Financial Secretary, A. B. Jones.

KINCARDINE BRANCH NO 12.—Meets every Tuesday at 8 o'clock, in McKibbon's block. President, Daniel Bennett; Vice-President, Joseph Lighthall; Secretary, Percy C. Walker, Waterworks.

WIARTON BRANCH NO. 13.—President, Wm. Craddock; Rec.-Secretary, Ed. Dunham.

PETERBOROUGH BRANCH NO. 14.—Meets 2nd and 4th Wednesday in each month. S. Potter, President; C. Robison, Vice-President; W. Sharp, engineer steam laundry, Charlotte street, Secretary.

BROCKVILLE BRANCH NO 15.—President, W. F. Chapman; Vice-President, A. Franklin; Recording Secretary, Wm. Robinson.

CARLETON PLACE BRANCH NO. 16.—Meets every Saturday evening. President, Jos. McKay; Secretary, J. D. Armstrong.

Canadian Electrical Association.

IT has been found necessary to largely increase the size of the present number of THE ELECTRICAL NEWS in order to admit of the publication of a complete report of the annual convention of the Canadian Electrical Association held in Toronto last month. The proceedings are of such an interesting and instructive character, and cover such a wide range of subjects in which our readers may be supposed to be interested, that we deem it scarcely necessary to apologize for the monopoly of space accorded to their publication. Of the convention it can be said, that especially in respect of interesting and instructive papers and discussions, it was a decided advance upon any of its predecessors. A higher average attendance at the sessions, and a deeper and more general participation in the proceedings, were encouraging features of the occasion. The use for the first time of lantern slide projected diagrams for the illustration of the papers had the effect of awakening a more general and deeper interest on the part of the members in the subjects under consideration. The addition of a considerable number of new members mainly from the ranks of the central station men is a cause of congratulation, and may be taken to indicate an awakening appreciation of the efforts which the Association has made to prove helpful to the electric lighting interests in conjunction with those of the telephone and telegraph. It is to be regretted that the various sections of the Dominion are not more equally represented on the Executive Committee, and especially that the city of Ottawa, whose generous hospitality can never be forgotten, is entirely without representation. We are sure that this and one or two other apparent blunders were due to lack of proper consideration, rather than deliberate intention. The result, however, is none the less regrettable, and care should be exercised to ensure justice being done in future to every individual and locality.

Mr. D. A. Starr has been appointed engineer in charge of the Hull and Aylmer electric railway.

The announcement has been made that the Babcock & Wilcox Company will consolidate their Canadian office with their general sales department at New York. From their various offices at Buffalo, Boston, New York, Minneapolis, Chicago, Cincinnati and San Francisco, it is believed that their Canadian business can be properly looked after, at much less expense. Mr. Wm. T. Bonner, formerly manager of their Canadian office in Montral, will remove to Atlanta, Ga., having been appointed manager for the south-eastern territory. The Canadian shops will be maintained, at which boilers will be manufactured as usual.

ONTARIO ASSOCIATION OF STATIONARY ENGINEERS.

The annual meeting of the above association was held at Galt on the first of June. Mr. Arthur Ames, president, occupied the chair. There was a good attendance and much interest manifested in the proceedings. The minutes of last meeting were read and approved.

The president, in his address, impressed upon the members present the great importance attached to the various offices, and urged that care be exercised in the filling of such, as the success of the association depended to a large extent upon its officers and members. The interests of the engineers of this country depended largely, he said, on their own endeavors to procure an education in the principles involved in operating a modern steam plant. The rapid strides made almost daily in the advancement of this science make an up-to-date knowledge of these facts indispensable. And it is being recognized that the opportunities offered by this and other similar societies, together with the various publications connected therewith, greatly facilitate the acquiring of such a knowledge. The association had progressed very favorably; 150 certificates having been issued by the registrar for the current year, making in all some 700 now in force in this province. The reduction of renewal fees on two previous occasions had a beneficial effect, but they were now as low as possible consistent with the proper carrying out of the affairs of the association. In connection with legislation, a joint committee from this association and the Canadian Association of Stationary Engineers was appointed to draft a measure, to be presented at the last session of the Ontario Legislature, to procure a compulsory law, but the very laudable attempt fell through, owing to lack of sufficient time. He hoped that further action in this direction would shortly be taken. Apalling boiler explosions have been frequent of late, attended by great loss of life, and he would ask that a joint committee of the Ontario and Canadian Associations be appointed to draft a workable measure such as will comply with the interests of engineers and steam users at large. He thought the steam users of this province were beginning to realize that the aim of these associations is to place before them competent men, a very important matter in these days of close manufacturing competition. With respect to the financial standing of the association, the president stated that considerable money had been spent in procuring a set of books for the registrar and treasurer. He asked the members to consider the advisability of changing the regular date of meeting to the 24th of May, as it would afford a greater number the opportunity of attending.

The committee on "Good of Order," Messrs. Wickens, Donaldson and Stott, presented their report, which recommended that the question of securing legislation be again taken up this year upon new lines, and that the registar be requested to call in all certificates out of date, and endeavor to collect the fees due.

The registrar, Mr. Edkins, presented his report and financial statement, the latter showing the receipts for the year ending 31st May, 1896, to be $641.41, and the expenditures $613.11, leaving a balance on hand of $28.30. The report stated that the success of the association was reason for congratulation, when the general depression in manufacturing industries was considered. During the year many certificates had been issued to craftsmen having charge of isolated plants, who voluntarily came up for examination in order to prove themselves qualified to act in the capacity of stationary engineers. Since the last yearly meeting three valued members had been called away, Messrs. B. Charlesworth, Hespeler, J. H. Walker, Paisley, and E. Edwards, Merritton. The association had at the present time a membership of about 600, but of these many were in arrears in the payment of fees, of which 59 were third class, 27 second class, and 6 first class. He asked instructions as to the course to be pursued to secure payment, and suggested the advisability of arranging the yearly renewal fee as follows: $1.00, 75c. and 50c. for first, second and third class respectively, if paid on or before the last day of February each year, and in default of so doing, the fees to be respectively $1.25, $1.00, and 75c. This arrangement would result in making members more prompt in payment. The fact that advertisements had appeared in the daily press asking for engineers holding Ontario certificates was considered encouraging.

The report of the treasurer was then read and adopted, after which the association adjourned for lunch.

At 2 p. m. order was again called, when the Committee on Legislation reported that after a good deal of work they had decided to postpone their efforts to secure legislation until the session of 1897.

The auditors' report was then presented and received.

Nominations were received to fill vacancies on the Board of Examiners as follows: Messrs. J. Bain, J. Devlin, F. Donaldson, F. Mitchell, P. Stott, and W. Sutton. A ballot being taken, it was declared that Messrs. Devlin, Donaldson and Mitchell were elected.

In the election of officers Messrs. Ames, Mitchell and Phillips were nominated for president, and Messrs. Devlin, Phillips and Mitchell for vice-president. Mr. Ames was declared elected for president and Mr. Mitchell for vice-president. Mr. Edkins, registrar, and Mr. Mackie, treasurer, were re-elected by acclamation.

Toronto was chosen for the next meeting place, and after discussing the question of changing the date, it was decided to adhere to the first Monday in June.

It was decided to memorialize the Dominion Government to appoint Mr. James Devlin as chief engineer of penitentiaries. A delegation, composed of Messrs. Devlin, Wickens and Edkins, was named to interview the same government on the question of obtaining a compulsory law for engineers.

It was moved by Mr. Phillip, seconded by Mr. Devlin, that the position of registrar in future should have a yearly salary of $100 attached thereto. The registrar stated that he would decline the position if any salary was voted.

Messrs. Cowan and Turnbull addressed the meeting, expressing themselves strongly in favor of the objects of the association, after which adjournment was announced.

An accident recently occurred to the dynamo in the power house of the Winnipeg electric railway which necessitated taking off some of the cars until repairs were made.

The Lachine Rapids Hydraulic and Land Company have decided to increase the capital stock to $2,000,000 and to proceed at once with the construction of the conduit and distribution in the city.

On June 19 fire was discovered in the works of the Thompson Electric Company at Waterford, Ont., which completely destroyed the building and machinery. The loss is placed at $30,000, about half of which is covered by insurance.

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS.

NOTE.--Secretaries of Associations are requested to forward matter for publication in this Department not later than the 25th of each month.

THE ANNUAL CONVENTION.

Arrangements are being made for the holding of the annual convention of the C. A. S. E. in Kingston on the 18th and 19th of August. It is expected some interesting papers will be presented, and the question of meeting in convention once in two years, instead of every year as at present, will probably come up for consideration. The local association are already arranging plans for the reception of delegates, fuller particulars of which will be given in our next issue.

MONTREAL NO. 1.

The election of officers took place at the meeting of the above association on June 18th, with the following result: President, John Murphy; 1st vice-president, J. E. Huntington; 2nd vice-president, William Smyth; secretary, B. Archibald York (re-elected); treasurer, Peter McNaughton; fin. secretary, Harry Nuttall (re-elected); corresponding secretary, Hugh Thompson (re-elected); conductor, John Glennor, (re-elected); door-keeper, Wm. McAlpin (re-elected); trustees, Thos. Ryan, John J. York, and John H. Garth; librarian, John Robertson.

The representatives to the executive council will be elected at the next meeting of the association.

TORONTO NO. 1.

Toronto No. 1, at their last regular meeting, elected officers as below: President, John Fox; vice-president, Chas. Moseley, recording secretary, Thomas Eversfield; financial secretary, Walter Blackgrove; corresponding secretary, George Mooney; conductor, Thomas Seaton; door-keeper, Barney Doyle; trustees, James Huggett, George Fowler, and E. J. Phillip. The delegates to the convention, to be held at Kingston in August next, are as follows:—John Bain, John Fox, James Huggett, A. M. Wickins and Charles Moseley.

HAMILTON NO. 2.

On Friday, June 19th, the above association elected the following officers for the ensuing year: Past president, W. R. Cornish; president, Wm. Norris; vice-president, E. Teeter; recording secretary, James Ironsides; financial secretary, A. Nash (re-elected); treasurer, Wm. Nash (re-elected); conductor, W. Jones (re-elected); door-keeper, Thomas Carter (re-elected); trustees, R. Mackie, P. Stott, R. C. Pettigrew; auditors, G. Mackie, James Ironsides, J. Wadge; sick committee, G. Mackie, W. Jones, Thomas Carter; delegates to convention to be held at Kingston, William Norris and G. Mackie. This association is reported to be in a thriving condition, an harmonious spirit existing among the members.

GUELPH NO. 6.

At a meeting of Guelph No. 6, at which there was a good attendance, officers for the ensuing year were elected as follows: President, H. Geary; vice-president, Thos. Anderson; recording secretary, H. Flewelling; financial secretary, P. Ryan; treasurer, C. F. Jordan; conductor, J. Tuck; door-keeper, J. Thatcher.

On behalf of the employees of the St. John, N. B., Street Railway Company, the superintendent presented Mr. George Wilson, the retiring chief engineer, with an address and handsome cigar case. Mr. Wilson thanked the donators for their expression of good-will.

PERSONAL.

Mr. H. Rawstran, cashier of the Montreal Street Railway Company, has resigned, to accept a lucrative position with a Chicago company.

Mr. C. Berkeley Powell and Mrs. Powell, of Ottawa, sailed a fortnight ago on the steamer Parisian for a pleasure trip in England.

Mr. M. B. Thomas has succeeded to the management of the Hamilton & Dundas Railway Company, vice Mr. W. N. Myles, who has resigned.

Mr. T. Ahearn, of Ahearn & Soper, Ottawa, is at present in England on a business trip in connection with enterprises proposed by his company in Australia.

Mr. George Yorke, engineer at Osgoode Hall, Toronto, is enjoying a wedding tour in England. Mr. Yorke was married on the 4th ultimo to Miss Sarah Robins.

Mr. Thomas Irwin, of Montreal, has been appointed chief engineer of the power house of the St. John, N. B., Street Railway, Union street, to succeed Mr. G. M. Wilson.

Mr. William McCammon, of Kingston, Ont., was drowned at Clayton, N. Y., by walking off the dock. Deceased was an expert electrician and had charge of the electrical machinery on Folger Bros.' fleet of steamers known as the "White Squadron."

Mr. W. H. Baker, Vice-President of the Postal Telegraph Cable Company, of New York, was a recent visitor in Montreal. Mr. Baker, in addition to being vice-president of probably the largest cable company in the world, having over 8,000 offices on the continent, is a well-known figure in the electrical world and has invented several electrical contrivances.

At the commencement exercises of the graduating class of 1896, from the Stevens Institute of Technology, Hoboken, N. J., held June 18th, 1896, the degree of Doctor of Engineering was conferred by the faculty and trustees of Stevens Institute upon Commodore George W. Melville, engineer-in-chief of the United States Navy, in appreciation of the excellent engineering work performed by Commodore Melville for his country and the advancement of the science of steam engineering, well illustrated in the world wide famed "White Squadron." Only once before in the twenty-five years history of the Stevens Institute has the degree of Doctor of Engineering been conferred, and then upon Professor R. H. Thurston, of Rhode Island, who formerly occupied the chair of Mechanical Engineering in Stevens Institute, and is now Director of Sibley College, Cornell University.

Mr. Horatio Whiteway Nelson, who has recently taken charge of the cable and wire department of the Royal Electric Co., Montreal, is an expert in the insulating business of long and varied experience. On completing his education he spent two years in travel around the world, and then joined the Edison Machine Works, of Schenectady, N. Y., where his work was attended with continuous success during five years. In 1889 he came to Canada with the Edison General Electric Co. and superintended the large wire department of that corporation at Sherbrooke and Peterborough for four years, when he accepted the position of general superintendent of the works of the Waddell-Entz Co., of Bridgeport, Conn., then employing some 300 men. Subsequently he was entrusted with one of the departments of Messrs. Washburn & Moen's great works at Worcester, Mass., which charge he relinquished to accept his present post.

TRADE NOTES.

J. Wallace & Son, of Hamilton, have just completed a machine for the manufacture of acetylene gas for Mr. T. L. Willson.

The Ottawa Car Company recently shipped two electric cars to the Berlin and Waterloo railway, and the same number to the Galt, Preston & Hespeler railway.

The following statement shows the geographical distribution of sales of Babcock & Wilcox water tube boilers during the month of May last, the figures indicating the horse power. American sales: New York, 774 h.p.; Pennsylvania, 300; Illinois, 6,400; Cincinnati, 330; Tennessee, 600; Canada, 1,742; total, 10,146 h.p. Foreign sales: England, 4,444 h.p.; New South Wales, 206; Scotland, 200; France, 686; Germany, 756; Spain, 722; Peru, 125; Norway, 280; Sweden, 57; Egypt, 1,728; Russia, 1,142; China, 160; Japan, 1,320; India, 46; Cuba, 75; Mexico, 64; total, 12,011 h. p. The grand total, including 1,920 h. p. marine boilers, is 22,157 h.p. The number of Babcock & Wilcox automatic chain grate stokers sold during the month was fifteen.

ACETYLENE GAS.

By Geo. Black

Great inventions and discoveries are often apparently the result of accident, but the seizure of the occurrence and turning it to account marks the true scientist; such was the case when our countryman, Thos. L. Willson, discovered his method of producing calcium carbide, for it was known to chemists as a rare product, as shown by the following references:

Sir Humphrey Davy observed that when carbon and potassium were heated sufficiently to vaporize the potassium, a substance was formed which has been recognized as the first reference to a group of carbides.

In 1836 Brezelius announced that the black substance formed in small quantities as a by-product in producing potassium from potassic carbonate, and carbon was carbide of potassium.

Wohler in 1862 announced that he had made the carbide of calcium by fusing an alloy of zinc and calcium with carbon. He ascertained that it decomposed in contact with water forming calcic hydrate and acetylene.

Berthelot in 1866 described sodium carbide or acetylene sodium. He discovered that the high temperature of the electric arc within an atmosphere of hydrogen would unite with carbon of the charcoal terminals and form acetylene gas.

In 1888 Willson, in experimenting with his electric furnace, trying to form an alloy of calcium from some of its compounds, noticed that a mixture containing lime and powdered anthracite acted on by the arc fused down to a heavy semi-metallic mass, which, having been examined and found not to be the substance sought for, was thrown into a bucket containing water near at hand, with the result that violent effervescing of the water marked the rapid evolution of a gas, the overwhelming odor of which enforced attention to its presence, and which on the application of a match, burned with a smoky but luminous flame and numerous explosions. It was Acetylene gas.

To Willson is due the credit of discovering how to make calcium carbide, at the price of about one cent a pound in unlimited quantities, instead of the rare laboratory product obtained in grains, at the rate of about $10,000 per pound, thus producing not only a new light, but for manufacturing and commercial purposes opening up a vast range of new combinations of hydro-carbons at a much cheaper rate than ever existed before. The dream of the Chemist has been realized and synthetic chemistry took several strides forward. The possibilities of cheap carbide for light or chemical combinations places Willson in the front rank of the scientific men of the age.

Calcium carbide, Ca C2, is described as a dark brown, dense substance, having a crystalline metallic fracture of blue or brown appearance, with a specific gravity of 2.262. In a dry atmosphere it is odorless, but in a moist atmosphere it emits a peculiar smell, resembling garlic or phosphorous. When exposed to air in lumps it absorbs moisture, and the surface becomes coated with a layer of hydrate of lime, which to a certain extent protects the rest of the substance from further deterioration. *It is not inflammable and may be exposed to the temperature of* a blast furnace without taking fire, the exterior only being converted into lime. When brought into contact with water or its vapors at ordinary temperatures, it rapidly decomposes, one pound when pure generating 5.892 cubic feet of acetylene gas at a temperature of 64° F.

Calcium carbide is manufactured from powdered lime and carbon in the shape of ground coal, coke, peat or charcoal, these two substances being fused together in an electric furnace. The process is very simple, and may be described thus:

The lime and carbon, having been ground to a fine powder, is intimately mixed in a certain proportion and fed into a crucible or furnace, the lower part of which has a carbon plate which is attached to one of the dynamo terminals; the other terminal is connected to an upright carbon resembling the upper carbon of an arc lamp, but much larger, being about three feet long and 12 by 8 inches in cross section. An alternating current is delivered by means of transformers to the carbons at about 100 volts and 1000 amperes. A small portion of the mixture is fed into the furnace, the upper carbon is raised about three inches to form an arc and the mixture is fused by the intense heat which ranges from 3500 to 4000 deg. C., while that of the ordinary smelting furnace is only 1200 to 1500 deg. C. The carbon is gradually raised and fresh mixture fed in till a mass of molten carbide about three feet high is made when the current is turned off and the carbide allowed to cool. The noise of the arc is said to be very peculiar, especially when the supply of mixture begins to fail.

COST OF CALCIUM CARBIDE.

To positively ascertain the cost of this product, the *Progressive Age*, of N. Y., sent three commissioners to Mr. Willson's aluminum factory at Spray, N. C., in March last, to investigate thoroughly, and their report is published in that journal under date of 16th April, 1896. The commission consisted of Messrs. Houston and Kennelly, well-known electricians, and Dr. Leonard P. Kinnicutt, Director of the Department of Chemistry at Worcester Polytechnic Institute, who investigated thoroughly and took full charge of the factory during two separate days, making two runs of the substance and taking samples with them for testing in their own laboratories. Notwithstanding that the factory at Spray was only an experimental one, and the greatest possible output only one ton per 24 hours, and the fact that transportation of material was excessive, costing $3.05 per ton for coke and $4.55 per ton for lime, and estimating $11 per day for labor, including a superintendent at $4 per day, they figure the cost at $32.76 per ton.

Messrs. Houston and Kennelly add a separate estimate for the production of five tons daily under more favorable circumstances, but with water power at $5 per year as at Spray, and figure the cost at $20.04 per ton. They add, "The cost of producing calcium carb electrically, is evidently limited by the cost of lime, coke and electric power, no matter what the scale upon which the process is conducted."

"If we assume a perfect electric furnace, in which neither material nor energy is wasted, that is, a furnace which ensures the complete union of calcium and carbon without loss and with no escape of heat in the process, we know that one ton of carbide would require for its production 1750 lbs. of lime and 1125 pounds of pure coke.

"It has also been calculated from thermo-chemical data that 1½ electrical h.p. hours will be almost precisely the right amount of energy to produce one pound of carbide, or 3000 h. p. hours per short ton of carbide.

"Consequently, if L is the cost of lime in dollars per ton, C the cost of coke per ton, and P the cost of an electrical h.p. hour, a theoretically perfect plant would yield carbide at a cost per ton, exclusive of labor and fixed charges, of 0.875 L + 0.5625 C + 3000 P.

"For example, if lime (assumed pure) costs $2.50 per short ton, coke (assumed pure) costs $2.75 per short ton and an electrical horse-power of 300 working days of 24 hours each, cost $12 at furnace terminals (0 1667 cent per working horse-power hour), the limiting cost of carbide in a perfect furnace would be $8.73 per short ton.

"We may therefore summarize as follows: Calcium carbide by the electric furnace cannot be manufactured cheaper than $8.73 per short ton—for material and power, exclusive of electrode carbons, labor, depreciation, interest and other fixed charges.

"Owing to impurity of materials and departure from theoretical perfection in the electric furnaces, we found at Spray the actual cost of material and power, irrespective of electrode carbons, labor, etc., is 1.335 L + 1.125 C + 5122 P.

"Under favorable conditions such as we believe can be realized in particular localities, the total cost per short gross ton on a plant whose output is five tons daily, might be $20. Under the actual conditions existing at Spray during our tests, *we find the total cost to be $32.76* per short gross ton if the plant were worked continuously."

In the above lowest estimate of Messrs. Houston and Kennelly they place horse-power at $12, whereas Mr. Willson has secured water power at Spray, and also in Canada, at a cost not exceeding $5 per h.p.

On this basis, and assuming L at 2.50, C at 2.75 and P 5.00, the figures would amount to 2.18 + 1.55 + 2.08, or a total of $5.81. The cost of lime and coke, however, is placed at a very low figure, but it is evident that the true theoretical minimum price is between $5.81 and $8.73.

I have also the following estimates of cost at the Niagara Falls establishment, to produce one ton of carbide, at rate of 10 tons per day.

It requires	200 Electrical H. P., 24 hours at $20 per year,	$10 95
	1,440 lbs. Coke @ $3.50 per ton..............	2.52
	1,800 lbs. Lime @ 4.50 per ton.............	4.05
	Labor, Depreciation, &c., &c.................	6.18
		$23.70

It is noticeable that this estimate is somewhat in excess of the theoretical values as laid down by Messrs. Houston and Kennelly, and may be improved on as experience is gained.

I was informed that the first run of carbide manufactured at Niagara Falls early in May gave about 25% better results than their estimate, and that *they hoped to improve still more as they gained experience* and the men got used to their work.

Mr. Willson commenced to erect a factory at Merritton in April on the old Welland canal, where he has secured 1500 horse-power at locks 8, 9 and 10, and expects to turn out carbide at the rate of 7½ tons daily at the lowest possible cost. He has also secured a very large amount of power in the province of Quebec, where he intends to manufacture not only for Canada, but for export to foreign countries.

It is quite evident from the report of the Progressive Age commissioners and from the experience of the Niagara *Falls Company that calcium* carbide can be made and sold at a price to compete with ordinary gas and electric light.

It takes to produce 100 lbs. carbide, as shown theoretically, 87 1/2 lbs. lime and 56¼ lbs. of carbon; of the latter 37 1/2 lbs. combine with the metal calcium and 18¾ lbs. combine with the 25 lbs of oxygen of the lime, and escapes from the furnace as carbon monoxide, in accordance with the following formulae:

Ca O + 3 C	= Ca C2	+ C O.
87½ lbs. + 56¼ lbs.	= 100 lbs.	+ 43¾ lbs.
Ca C2	= Ca	+ C2.
100 lbs.	= 62½ lbs.	+ 37 1/2 lbs.
C O	= C	+ O.
43¾ lbs.	= 18¾ lbs.	+ 25 lbs.

Calcium carbide contains 62.5 parts of calcium and 37.5 parts of carbon in 100, and when brought into contact with water acetylene is generated to the extent of 5.89 cubic feet of gas to each pound of carbide used; or by weight 100 lbs. of carbide and 56¼ lbs. of water evolve 40.63 lbs. of acetylene gas and form 115.62 lbs. of calcic hydrate (slacked lime) in accordance with the following formula:

Ca C2 + 2 H2 O	= Ca O H2 O	+ Ca 2 H2.	
100 + 56.25	= 115.62	+ 40.625.	

The acetylene gas so generated, contains in 100 parts 92.3 parts of carbon and 7.7 parts of hydrogen, or in the 40.625 pounds generated from 100 lbs. of carbide we have 37 1/2 lbs. of carbon and 3⅛ lbs. of hydrogen.

Acetylene can be produced from carbide by the addition of water and distributed and stored in a gasometer, or the gas may be compressed into a liquid and kept in a suitable cylinder and drawn off as required for consumption, a reducing valve being adjusted to give the necessary pressure for burning. One cubic foot of liquid expands into 400 cubic *feet of illuminating gas, so that a large supply may be stored in a very* small space, but for experimental purposes and for a limited supply it is preferable to make the gas direct from carbide and store it in a gasometer.

The pressure necessary to liquify acetylene depends upon the temperature. At 67° it requires a pressure of nearly 600 lbs., at 32° 323 lbs., at 28.6° below zero 135 lbs., and at 1160° below zero 15 lbs. We see that there is no danger of freezing it in any habitable place.

As an illuminant acetylene surpasses in brilliancy all other illuminants known. When burned at the rate of 5 *cubic feet per hour it gives* 240 to 250 c.p., whereas the best coal or water gas rarely exceeds 22 candles for each 5 cubic feet burned per hour. Acetylene gas thus gives 10 to 12 1/2 times the light of ordinary gas, or 1000 feet is equivalent to 10,000 to 12,500 of ordinary gas. Acetylene is a commercially pure gas, containing 98 per cent. acetylene and 2 per cent. of air, the latter having slight traces of other substances. It is clear and colorless, with specific gravity of 0.91.

When a light is applied to acetylene in open air, it burns with a bright yellow but very smoky flame, on account of its extreme richness *in carbon, but when confined* and delivered under suitable pressure it gives an extremely pure white light resembling the oxy-hydrogen light, and is the nearest approach in color and purity to sunlight of any known artificial light.

ITS POISONOUS NATURE.

Acetylene, when made from expensive chemicals, was known to be very poisonous, but as made from lime and carbon it is proved to be less injurious than ordinary gases. Its strong pungent smell is a safeguard, as no one can remain in an atmosphere of it a sufficiently long time to be harmed; handy for hotels where the guests blow out the lights; in such an event the "Blowhard" could not get to sleep before he or some one else would be compelled to investigate. The effect on the human system is rather to intoxicate than stupify, and while it is absorbed by the blood it does not form combinations with it; it asphyxiates less rapidly than ordinary gas. Moissan of France and others made exhaustive experiments with the greatest care with acetylene and coal gas on animals, and proved conclusively that coal gas was much more poisonous *than acetylene.*

EXPLOSIBILITY.

Acetylene, when mixed with 1 1/4 times its volume of atmospheric air, becomes slightly explosive, and reaches its maximum explosibility with 12 volumes of air, decreasing till at 20 volumes it ceases to be explosive. Coal gas reaches its maximum explosibility with 5 volumes of air, so that ordinary gas is more explosive than acetylene. Accidents and explosions reported recently have given the impression that the gas is very dangerous. Let us examine this feature. Take the case of the accident in Quebec last winter. An ingenious mechanic made his own *dynamo, furnace* and carbide; he was experimenting with the gas under pressure, to liquify it so as to get it into the smallest possible space. He had an iron pipe 8 inches long and 4 inches diameter with cast iron ends, a pressure gauge at one end and a valve at the other. He had reached a pressure of 360 lbs. to inch, and observing that the gas was escaping around the valve, he used a hammer to stop the leak, when a a portion of the metal broke away and the gas escaping struck him in the eye, penetrating the brain and killing him instantly. Ordinary air under similar conditions would have been as fatal. It was afterwards found that the iron ends were thin and porous and the wonder was that they stood the pressure. There was no explosion; the coroner's verdict was "accidental death."

The explosion at New Haven, Conn., 21st January last, was caused by men experimenting with liquid acetylene, under a pressure of 600 lbs. to the inch, and I presume all accidents reported might be traced to unauthorized parties experimenting with crude apparatus, and ignorant of the necessary conditions for safety. We know that air, water, gas or electricity, are dangerous under certain conditions, but harmless when properly controlled, and it is no argument against acetylene that it is also dangerous when improperly handled.

EFFECT ON ELECTRIC LIGHTING.

When I first saw acetylene gas in September '94 I felt sorry for the electric companys, because I thought the gas companies would readily adopt the new gas and regain their former monopoly of lighting. But I do not feel quite so downcast now; I realize that the margin of cost of production is not so great, and believe that gas companies will feel the competition equally with electric, unless they adopt the new gas for use pure, or as an enricher to their present output. It is said to be useful as an enricher for coal gas, but not so suitable for water gas.

Prof. Lewes, of England, one of the best gas authorities there, suggests that gas companies should distribute a low illuminating coal gas of about 12 c.p. through their mains for heating, cooking, etc., and that each place using illuminating gas be supplied with a cylinder of acetylene to be fed into the illuminating pipes in a certain determined proportion. By some such process as this there remains a large field for coal gas; otherwise coal and water gas must go.

The incandescent light has held first place for interior illumination on account of its steadiness, purity, coolness, and not withdrawing oxygen from the air nor adding noxious elements to it. Acetylene will divide this field with the incandescent bulb; it is a pure, white, steady light, of low heating power, withdraws very little oxygen from the air, and does not add impurities to any great extent. Its flame has a temperature of 900 to 1000 degrees C., while ordinary gas has 1400 deg. C., but as only one-tenth to one-fifteenth of the quantity is used for equal light, its heating effect is slightly in excess of the incandescent bulb.

Taking the theoretical E. H. P. necessary to produce one ton of carbide as 3000 h.p. hours, and using the same for a supply of electric light by incandescent 4 watt lamps, we have the following: $3000 \times 746 = 2,238,000$ watts $\div 64$ gives 34,970 16 c.p. lamps for one hour, or 1453 burning 24 hours continuously.

The same power equals one ton carbide, which burned in ½ foot burners gives 31,500 16⅔ c.p. lights, or 1,313 burning 24 hours. This gives a margin apparently in favor of electric lighting, but you cannot use all your electric lights at the source of cheapest production, nor run a continuous even load for 24 hours, but have in addition to sustain losses in distribution more than proportional to the distance conveyed; also lamp renewals. With the carbide it is different; it can be made at the place of cheapest production on a constant load night and day, and a small sum transports the carbide to any place desired, where it can be used to its full power without loss. Figure out for yourselves the problem of transmitting electric current for use 10 to 100 miles from source of production and transporting carbide by freight the same distance, and the comparison will be largely in favor of carbide. Hence, for use in close proximity to the power house on a steady even load day and night, the cost will be about the same if power costs the same, but as that is not practicable in electric lighting, the margin is in favor of carbide, but not to such an extent as to seriously hurt the electric companies employing the best apparatus under the most improved conditions, as may be found in large cities, but it is possible in small towns where the best and most economical conditions cannot be obtained and a thorough manager secured, well up in the scientific as well as the practical conditions, electric lighting may suffer.

The ease of distributing acetylene is remarkable. Owing to its high illuminating power, very small main pipes may be used, and as frost does not affect it the pipes need only be laid below the surface, so that *little or no expense need be incurred in piping a town. If the cost of* mains equal cost of poles and wires the central station or gas house only requires a small tank for a generator and a gasometer of suitable size, as compared with engines, boilers and dynamos running when only one light is required.

We may then conclude that in the race for supremacy closer economy will be practised, better service given, the public will be benefitted, all will let their light shine to the best of their ability, and the one best deserving of patronage will survive.

POWER TRANSMISSION BY POLYPHASE E. M. F.'S.

By Geo. White-Fraser.

The utilization of the natural resources of a country is a matter which should interest not only the engineer upon whom devolves the responsibility of their development; not only the capitalist who is on the look for investments, but the economist and the politician who have the grave responsibility of directing a nation's energies into remunerative channels.

The possession of cheap natural power, whether in the form of coal fields or large rivers, is a national asset, the importance of *which it is impossible to overestimate, constituting as it does the* very basis whereon rest those manufacturing industries that go towards making a nation self-supporting and progressive. The foundation of Great Britain's commercial pre-eminence is her immense coal fields, enabling all processes of manufacturing art to be carried on inexpensively, and thus giving her a very favorable start in competition with other manufacturing nations. Another favoring circumstance is that her immense deposits of iron ore, are if not in all cases contiguous to, at least very close to, the coal fields. The power, therefore, is nearly on the spot where it is wanted, and owing to her insular position, the great highway of commerce—the ocean—is at *the very doors of her factories.* Great Britain, probably, has ideal manufacturing and shipping facilities: raw material, raw power, natural highway, all packed into a very restricted area. In Canada, we have the three necessaries—raw power, raw material, great highways, but we rarely find them all present at the same spot. Nature gifted Great Britain from the outset; Canada must turn to science for the development and utilization and the combining of those scattered advantages. We have great and reliable water powers, we have immense natural wealth in ores, and timber, etc., and we have the highway of the great lakes and river. Governmental and private enterprise has provided, as well, *railway and canal transporting* facilities, but we frequently observe that the power sources are so situated as to be comparatively inaccessible to railways. Thus manufacturing establishments, in order to avail themselves of the former advantage, have to locate themselves unfavorably with respect to the latter. The cost of handling, transshipping, etc., being a very appreciable factor in the total market cost of manufactured articles, the cost of an additional link between the producing point and the shipping point, is sometimes so great as to make it commercially less expensive to locate at the shipping point even though that involves the use of a more expensive power. *Any means therefore that enables cheap power to be* brought to the most convenient shipping point, effects a combination which is of the greatest value to a manufacturing community. The intense competition in all manufacturing industries has the inevitable tendency to lower selling prices, and this reduction of profits must be made up either by a depreciation in the quality of the products, or by a rigid system of economy in manufacturing processes. The cost of production must go down, and any means of lowering it must be availed of. We use the most efficient machinery, we concentrate our factories round the best shipping places, we go where labor is cheapest, where power is cheapest, land cheapest, *transport most handy.* We do anything to save a cent in a hundred dollars, and upon the engineer frequently falls the responsibility of saving it. In his hands the policy of concentration becomes one of the principles of power generation, as in business; and power distribution receives as close attention as does the distribution of the goods. He wants to generate the power as cheaply as possible, and to transmit it to the utilizing points with the least waste; and he avails himself as far as possible of every natural advantage—natural gas, water for condensing, water falls, etc. We are all acquainted with the usual means of transmission—by belting and shafting, gears, hydraulic and pneumatic pressure, and so on; and know that the frictional and other losses by these methods are so great that very soon a limit is reached, beyond which it is not commercially possible to transmit. Hence we find, not only in manufacturing towns and villages, but even in the larger factories that several generating points are necessary, when but for these losses one very large *and very efficient central generating plant might furnish all the* power required throughout the entire area or district. It is, therefore, also that thousands and thousands of horse power are running to waste every day, in the many powerful rivers that drain parts of Canada. It is simply because the nearest railway, *or other shipping point* is so far distant from the waterfall that the power cannot be transmitted to a factory on the railway, and the extra haul and cartage would introduce an additional expense that would be prohibitory. If the power could be transmitted at reasonable cost from the water power to a convenient point on the railway, then the utilization of the cheap power and the good *transport facilities might together be commercially advantageous.*

It is now some years since the suitability of electricity for the transmission of power was recognized, and we have seen electrical machinery coming more and more into use, ousting other methods and proving its superiority, not only on practical but also on commercial grounds. We have seen generators grow from

25, 50, 100 h.p., to 1,000 h.p. in size per unit; we have transmitted the power at constantly increasing voltages up to 500 v. for direct currents, (or even greater in series machines,) and we have seen the direct current evolve into the alternating simple, and thence into the latest and highest type, the polyphase alternating; and to-day we find thousands of horse power transmitted at pressures of 10,000 volts, from waterfalls on a mountain, or in a gorge where it is impossible to locate a factory, and over distances ranging from a few hundred yards to thirty miles and more; we find these large amounts of energy being utilized for every industrial and domestic purpose, in units of from 1/8th to 1,000 horse power.

This tremendous widening of the field of electrical possibilities has not been attained by natural growth only. As the field widened the science developed; improved methods had to keep pace with increased demand, and while it was originally the demand that stimulated the invention of polyphase currents, polyphase currents have in their turn practically revolutionized the art of electrical generation, transmission and utilization, and the old formula c = e ÷ r that was a light unto the path of the direct current man, is no longer sufficient in the calculation of alternating current circuits.

It is the development of polyphase working that has rendered commercially possible the electrical transmission of power over great distances, and its reconversion into mechanical power when required. *Polyphase currents are merely ordinary alternating currents*; are generated separately as such, and possess no peculiar properties in themselves. Owing, however, to their difference in phase, the fields produced *by them* have different values at the same instant, and it is in this alone that the peculiar properties of the polyphase system reside. As they are, however, alternating currents, all those peculiar phenomena met with in alternating current work are inherent in polyphase working, and as a rule assume an importance which claims very careful consideration. Owing also to the combination in the same circuit of several E.M.F.s differing in phase, complications arise which are not present in single phase circuits. Before preceeding to the consideration of the mutual actions and reactions of these quantities, it may be of interest to trace the progress of evolution of electrical working from direct current, through simple alternating, up to polyphase alternating. Up till quite recently direct current was the only means of power transmission and distribution; but the limit of pressure necessarily imposed on this method was so low that the cost of copper for large areas or long distances became prohibitive, and recourse was had to the alternating current used with static transformers. By this means transmission voltage could be as high as required, and utilization pressure as low, but here again was a very vexatious limitation due to the fact that motors could not be made to operate satisfactorily on the alternating current. Once started and brought up to speed, they would go on until overloaded, and then stop; but it required some independent source of power to start them, such as a steam engine. It is quite evident that such motors could not start from rest, as each armature coil was subjected to equal forces acting in opposition to each other and therefore neutralizing each other; it was like the dead centre of an engine. This was the stationary field of an ordinary D.C. motor. This difficulty was overcome by the formation of a revolving field, and polyphase currents are necessary for this purpose. The principles of the revolving field are the same as those governing the resultant of mechanical forces acting in different directions on the same mass. Suppose a mass

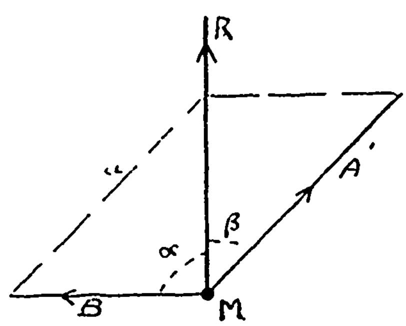


Diagram 1.—Parallelogram of Forces.

"M" and two forces "A" "B" acting with known strength on it in the directions of the arrows. The direction in which M will be forced—the resultant direction of the forces—will be MR, which is the diagonal of the parallelogram formed by drawing parallels to A and B. Now, it is plain that

$$\frac{\text{Side a}}{\text{side B}} = \frac{\text{sin angle RMB}}{\text{sin angle BRM}} = \frac{\text{sin angle RMB}}{\text{sin angle RMA}}$$

and as side a = side A, therefore

$$\frac{\text{side A}}{\text{side B}} = \frac{\text{sin RMB}}{\text{sin RMA}}$$

and that if we cause sides A, B, to vary harmonically we shall also cause angles RMB, RMA to vary harmonically; and consequently we can cause the diagonal MR to swing between positions MB and MA. Now MR is the *resultant of two forces acting* together; consequently if we cause these forces to vary harmonically in strength (remaining constant in direction) the resultant direction will swing as above described. Applying this principle to magnets, and an armature, we can cause the resultant magnetic field to revolve. Two electromagnets, A, B, are placed radially, and are separately energized by currents which can be varied in strength by any convenient means, say a rheostat. From the centre R of this arc, as a pivot, is hung an armature M capable of swinging. First of all magnet A is energized, B being left dead; M is directly attracted to A, and RM is the direction of strongest magnetic pull. Then A is left alone, and B is gradually energized, and as it becomes stronger it attracts M more and

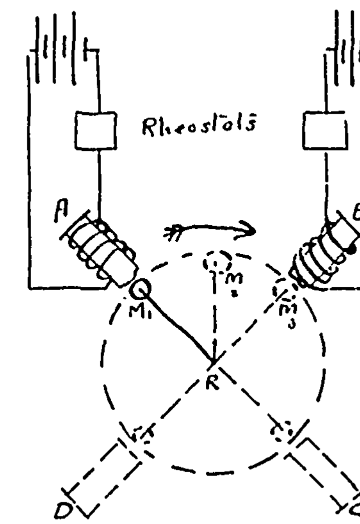


Diagram 2.—Harmonically Varying Magnet and Armature.

more towards itself, so that when *B has been made as strong as* A, each of them attracts M with equal force, and M will be held midway between them; RM2 being the new direction of magnetic strongest pull. If now A is slowly decreased, it will attract M less and less strongly, M *will approach closer to B, the strongest* direction RM3 will be the resultant pull. Thus, by causing the magnets A, B to vary in strength, one up, the other down, we have swung the resultant strongest field over the arc AB, of the circle. If we have other magnets, C, D, we could pull M all round the circle, and that is what is done in polyphase work.

The two necessary conditions for the production of a revolving field are electromagnets whose strength can be varied up and down, and some arrangement whereby adjacent magnets shall attain their maximum or minimum strength at different moments. The first condition is evidently met by energizing the magnets with alternating currents, *for in this manner their strength will* assume every value between a positive and negative maximum, passing through the zero point; and the second is evidently equally met by energizing two adjacent poles, by two independent alternating currents, one of which starts *a little later than the* other. A glance at the diagram will make this plain. Wave I

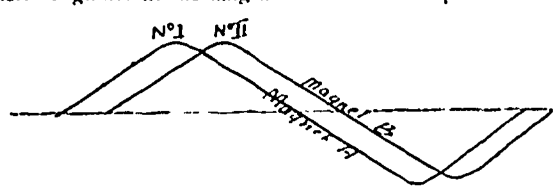


Diagram 3.—Waves.

energizes pole A, wave II energizes pole B. The current in an alternating circuit also rises and falls as does the E M F, and therefore the ampere turns, and consequently the magnetism. Wave II being a little behind wave I, as regards their equal strength, (strength being proportional to vertical height of wave above zero line) the magnetism in pole B will be behind that in pole A, and we have thus produced harmonically varying poles. It must be clearly understood that the principle of revolving poles is applied only to motors; the function of generators being to supply those *shifted E M F's and currents. These shifted E M F's can be supplied* by the same generator, or by several generators, the method employed being rendered plain by the diagram. N, S, are two

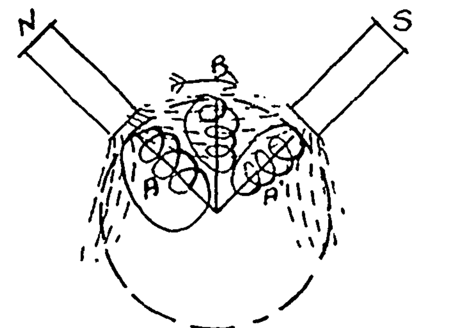


Diagram 4.—Generation of 2 Shifted E M F's.

poles—part of a ring yoke. A, B, are two coils of the armature. The angular distance of A, B, is half that of N, S. When A is right under N, it is generating its maximum E M F; at that moment B is halfway between N, S, and its induction and therefore its E M F is least. As the armature revolves clockwise, B gradually gets into a stronger field, while A is approaching a weaker one. The induction, and therefore the E M F in B is increasing while that in A is decreasing; when B has got under S, its induction and therefore its E M F is greatest; at this moment A is in the midway position, and therefore its E M F is least. Therefore, in these two coils are being generated E M F's which are shifted that is out of phase and if we take the values of the E M F's in each at the same instant, we can construct two curves, showing the position of their maxima and minima, etc., with respect to each other. Diagram No. 3 shews these two curves. If these E M F's were taken through separate circuits and joined respectively to poles A, B, in diagram No. 2, we should have the simplest form of polyphase generator and motor. Instead of having two coils A, B, between the poles N, S, we might space three, or any other convenient number producing 2 phase, 3 phase or 4 phase E M F's. As, however, the principles of polyphase E M F's apply to any number, and there is no advantage in using more than three, we shall not consider any higher number. In a polyphasal generator it is evident we can have just as many complete circuits as there are phases. In a 2 phase there are two sets of independent coils; the ends of these *might therefore be brought to four contact rings, and the ends of* the three independent sets of a 3 phase might be brought to 6 contact rings, as the ends of a single phase are connected to two contact rings. But a study of the wave diagrams of a 2 phase and of a 3 phase circuit shew that we can greatly simplify matters, and do with less copper. Take a more simple diagram of two phase coils at right angles to each other. In the upper

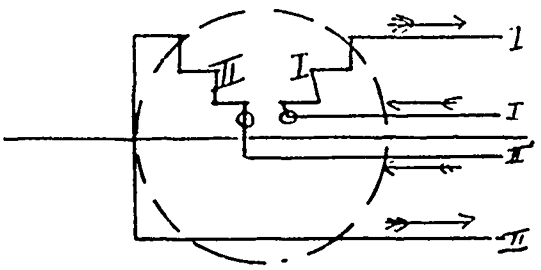


DIAGRAM 5.

half of the E M F circle, the E M F in each coil is positive and the current will flow from the outside end of the coil towards the inside end, in the direction of the arrows; here the E M F in each of the return wires is in the same direction, therefore we can combine them into one, instead of having two. Suppose the coils have revolved into the second position; here the E M F in the 2nd

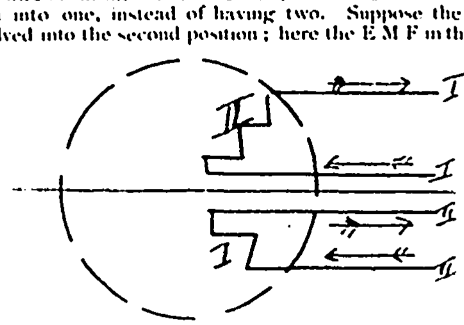


DIAGRAM 6.

coil is positive current flowing in the same direction as before. *The E M F in the 1st coil is however negative (the coil being below* the horizontal diameter) and the E M F will have reversed; therefore the current in 1 will now flow in the opposite direction to what it did before—in the direction of the new arrows. But it is plain that here again, if we join the outside ends of 2 and 1, the return current from 2 can flow down 1, the E M F's being in the same direction. Therefore in the two phase system instead of having two separate circuits we can join the inside ends of the coils—and

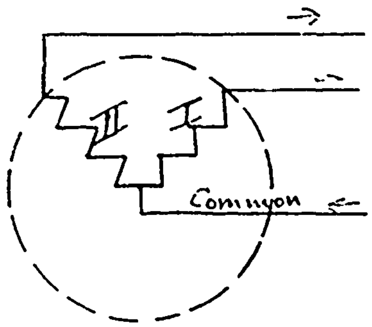


DIAGRAM 7.

lead three wires from the join and from the two outside ends as shewn in Diagram 7.

Similarly with the 3 phase system we can join the inside ends together, and lead four wires as shown in Diagram No. 8. But in this case it will be evident that we can dispense with the fourth wire altogether, as will be plain from the accompanying Diagram, No. 9, where the direction of the E M F's in the three wires at three different positions of the coils shew that always two wires can help to carry the return current of the third, therefore the fourth is not needed.

But while this combining of circuits very much simplifies the matter from the above point of view, it very considerably complicates it from another, because, whereas, with the individual

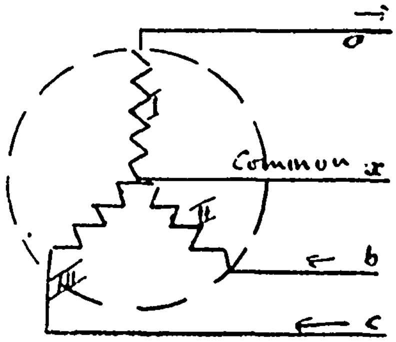


DIAGRAM 8.

circuits we had a single E M F to each, by combining them we have several E M F's of differing phase all acting in the same circuit—hence it is necessary to find their resultant E M F. This resultant

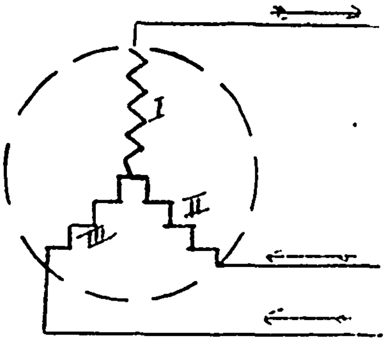


DIAGRAM 9.

depends greatly on the way in which the armature windings are connected up. There are three ways: "star" and "mesh" and independent groupings; the former is when the coils are all joined together at one end, the other ends leading to the circuits, as in Diagram No. 9. The second, where the winding is continu-

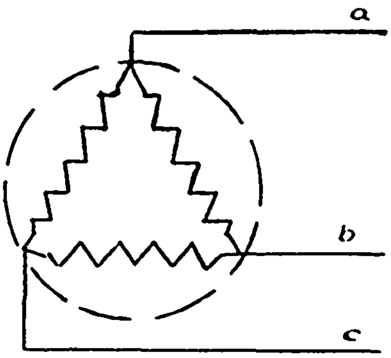


DIAGRAM 10.

ous round the entire armature and at intervals a circuit wire is tapped off, as in Diagram No. 10.

Diagram No. 11 shews 2 phase star connection, and here the

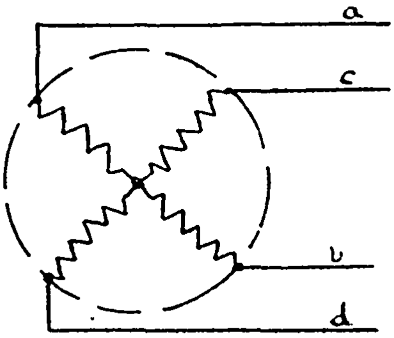


DIAGRAM 11.

instantaneous E M F between terminals a, b, and c, d, is 2 E sin O where E is the maximum voltage, and O is the angle through which the coil has passed from the position of no E M F. At the same instant the E M F between terminals a, c, b, d is $\sqrt{2}$ E sin (O + 45); that is to say the pressure between two live wires of different phase is $\sqrt{2}$ times or 1.41 times the pressure between the terminals of the same coil, and is 45° in advance of the E M F of the foremost coil. If a common return be used, the pressure between either outside and the common return will be simply double the E M F of one coil, but the pressure between the two outsides will be $\sqrt{2}$ times this. If two phase coils are connected in "mesh," it is plain that between wires a, b, there is simply the ordinary voltage of coil a or E sin O; while between wires a, c, there is a voltage of $\sqrt{2}$ E sin (O + 45°); or again 1.41 times the other voltage.

Similarly with 3 phase E M F's. Instant connection voltage between a and x is E sin O; that between b and x is E sin (O+120°); that between c and x is E sin (O+240°). The pressure between any two wires is $\sqrt{3}$ E sin (O+30); or if the pressure between one wire and the junction x is 1,000 volts, the pressure between any two wires is $\sqrt{3}$ times as great or 1730 volts. If a 3 phase armature be connected mesh fashion then the voltage between any two wires is simply the voltage of a coil. Diagram No. 10.

Consequently in wiring transmission circuits we want to know how the coils are connected. The amounts of current in the lines are calculated similarly, and the general result arrived at is that in the star winding the E M F's between line wires is greater than that due solely to the coils; while the currents in lines and coils are the same; while in the mesh winding the currents in the line wires are greater than the currents in the coils, but the EMF's are the same. Of course these increased EMF's and currents must have their effect on the size of the wires used with such polyphase E M F's; and, not to go into the mathematical investigation of this matter, which can be found in papers by Steinmetz, Thompson, Weaver and others, we can summarize the results as follows, comparing the amounts of copper required by various systems, to transmit same power, at same loss and same virtual voltage, *referring them to the* standard of single phase alternating unit:

Single phase		100	per cent.
Two phase	4 wires	100	"
" "	3 "	72.8	"
Three phase	3 " (mesh)	75	"
" "	4 " (star)	33.3	"

Having now seen the necessity for a revolving field; having examined into how to produce it; and having also investigated the peculiar E M F consequent of its use, we may reasonably turn to the consideration of what we can do with it. Briefly, we can make use of the advantages offered by the alternating current system in the transmission and utilization of power. We can transmit at any voltage we please and utilize at any other voltage we desire. We can concentrate a *highly efficient* steam and electric plant in a factory, village, town or city and send power in every direction in units of any size at a very reasonable cost. We can build our factory right on a railway and load our goods onto the cars at once, and at the same time make use of the abundant cheap power now running to waste over a ledge of rock twenty miles away, to run the machinery. In fact, we can conveniently and cheaply bring our power *from where it is being generated* by nature's agency, and lay it down just wherever *commercial considerations point to* as being the best spot for its use. At this present moment we have large amounts being transmitted up to 30 miles and over, perhaps; and the very first long distance transmission, which was undertaken in '91, remains to-day a monument of what is possible where enterprise, skill and capital combine to effect a particular object. The Lauffen-Frankfort transmission plant transmitted 300 horse power over a distance of 110 miles; and the efficiency of the entire plant was so large as 75 per cent. Thus the advantages of cheap power and of concentration and efficient distribution are rendered available by means of polyphasal currents.

It has already been said that a polyphasal system is merely the mechanical combination of several single phase alternating systems, and it will therefore be evident that all the conditions inherent in single phase alternating systems will be met with in polyphase working. As the distance and power requirements that caused the evolution of the latter, are in general *much more onerous than those imposed on the former*, so we *find that the reactions attending the use of the alternating current* as such, *have a much* more appreciable influence and require more careful attention in polyphase power work than they do in single phase lighting work. Whereas in alternating lighting plants the reaction and influence of hysteresis, induction, capacity are negligible or comparatively so, when large amounts of power are to be transmitted over great distances, they not only become appreciable, but a c a very considerable factor in the calculation of the circuits and the size of the generator units.

Hysteresis is a phenomenon attending the magnetization of iron by alternating currents; it is a sort of magnetic friction, and requires power to overcome it.

Induction is an EMF generated in a wire by the imposition on it of an alternating EMF and tends to oppose the the impressed EMF. It thus requires a higher initial or generator alternating EMF to send a desired current through a circuit possessing inductance than it would to send a direct current through the same circuit. *In* such a circuit there is not only the usual Ohmic drop, but also the inductance drop, and as these two sources of drop act, not in the same line but at right angles to each other, the resultant impressed E M F is compounded of the required effective E M F; the resistance E M F, and the inductive E M F.

Capacity is a sort of absorbing quality in the wire which requires to be, so to speak, saturated *before it will transmit any current.* Its effect is to require a larger amount *of current to be generated than would be required if a direct current were being* transmitted. The effect of induction is not only to introduce a drop of its own over and above the Ohmic drop, but it actually dams back the currents in the circuit so that the EMF wave and the current wave are out of phase with each other; that is they do not attain their maximum or other symmetrical values at the same instant.

The effect of capacity is different in one sense to that of induction, in that it requires the generation of a greater current instead of a greater EMF, and opposite *in* another sense, in that it tends to cause an advance of the current wave in front of the EMF. The combined action of these two quantities is called the reactance of a circuit, and as it generally happens that the inductance is greater than the capacity, there is a "lag" of current wave behind the EMF. The relative displacement of these waves is shown in Diagram No. 12. This lag angle has a very important influence on the

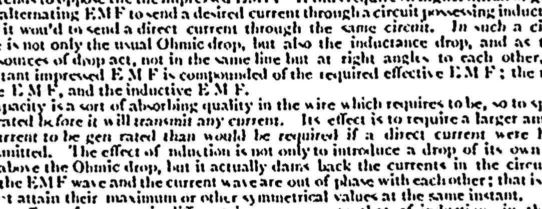


Diagram 12.—Lag of Current Wave Behind E. M. F.

power transmitted. The reactance of a circuit acts at right angles to the resistance, and the EMF required to overcome their combined action is equal to the square root of the sum of their squares, thus total drop = $\sqrt{R^2 + (React)^2}$. The total drop is called the impedance of the circuit. The lag angle is found thus:

$$\tan \text{lag} = \frac{\text{reactance}}{\text{resistance}}$$

Hysteresis may be at once dismissed from further consideration, as, though present in generators, transformers and motors, it does not enter as a factor into transmission, but *merely as one of those machine data of which engineers inform themselves when planning an enterprise. It must be said, however, that the expression for the energy* lost in hysteresis is $H = A \times B^{1.6} \times N \times M$.

Where H = Energy consumed in ergs.
A = Constant depending on magnetic hardness.
B = Density of induction in lines per CM²
N = Frequency of alternations.
M = Mass of iron in CM³.

Other things being equal it would be advantageous therefore to keep the frequency down and to have the density low.

The expression for the induction EMF of a circuit is $L = 2\pi N L C 10^{-3}$.

Where L stands for induction EMF.
2π is the usual symbol.
N stands for our old friend the frequency of alternation.
L stands for the specific inductance of the circuit, and depends on size, length, and mutual distance apart of wires.
C stands for the current in the conductor.

Studying this expression, we observe that the inductive E M F, or L, as it will be called, increases directly with the current, therefore, other things being equal, it is of advantage to lessen the current as much as possible. This is entirely in keeping with the idea of alternating current work, as the use of a high voltage permits of a small current to give the same energy transmitted. We observe again that L varies directly with the frequency of alternations, so that other things being equal, the use of a low frequency is of distinct advantage as tending to keep down the induction EMF. (This last deduction, it must be observed, applies to the circuits only.)

The expression for the capacity current of a condenser is $C = 2\pi N K E 10^{-6}$.

Where C = the current.
2π is the familiar symbol
N is again the frequency of alternations
K is the specific capacity of the condenser.
E is the impressed voltage.

Studying this expression we see that this capacity current increases directly with the frequency, and also directly with the impressed EMF. The factor K depends on the cross section of the wires and their distances apart decreasing as the wires become smaller, and as they are placed further away from each other.

Placing the three expressions for these quantities together:

$$H = \pi B^{1.6} N M \quad (1)$$
$$L = 2\pi N L C 10^{-9} \quad (2)$$
$$C = 2\pi N K E 10^{-6} \quad (3)$$

We observe that the symbol "N" standing for frequency of alternation is a prominent factor in all, and that the amount of hysteresis loss, of induction EMF; and of capacity current; all of them become greater as the frequency increases. From (2) we see that to transmit a certain amount of energy we should lessen the current as much as possible in order to reduce the inductive drop, and therefore use as high an initial EMF as possible. But from (3) we see that precisely the reverse relation of EMF and current should obtain if we wish to reduce the capacity current to a minimum. In this as in all other cases, a balance must be sought for, and commercial considerations must have the casting vote.

I wish to draw your particular attention for a few moments to the retardation of the current behind the electromotive force, brought about by the induction of lines or apparatus, as it has a most important bearing on the transmission of power. The power or energy of a circuit is, as we know, the product of the amperes into the volts; but owing to this lag the actual power transmitted is less than the amount calculated by multiplying the amperes and volts; and it becomes less in proportion as the lag becomes greater. This will be rendered evident by studying the diagram No. 12, *where it is seen that the maximum current flow occurs when the EMF has* passed its maximum; and consequently at no time can the power of an alternating current circuit containing induction be equal to the power of a D C circuit of same data. Quantitatively the power of such a circuit is equal to C × E × cos a, where "a" is the angle of lag. This expression follows directly from a consideration of the diagram connecting generator E M F, reactance and effective E M F, where *it is observed that the effective* E M F equal to the generator E M F × the cosine of the lag angle a. The less the reactance, the more nearly does cos a approach unity, and the less is the power lost in the line. The cosine of the lag angle is called the "power factor" of the circuit, but in figuring the power factor for a particular case, we have to take into consideration not only the reactance of the lines, but also that due to the self induction of transformers and motors, so that the calculation of the resultant power factor of an entire system, becomes a somewhat complicated matter. *It* is an absolutely necessary matter, *however, because the* generator capacity and EMF have got to be larger than the actual power required at motors, by the amount "x secant a," where x is the amount required of the motors. We first have the line power factor; imposed on that comes that of the transformers, and lastly that of the induction motors, so the resultant power factor is really a quantity to be reckoned with.

In this place it will be apropos *to consider that peculiar condition of equilibrium*—called resonance—brought about by introducing sufficient capacity into the line to neutralize the inductance. In this extreme case we shall have no reactance, only ohmic resistance; the current will be actually in phase with the EMF, and owing to the fact (as pointed out by Steinmetz) that the capacity EMF will be in the same direction as, and therefore additive to the impressed EMF, the resultant EMF will be actually higher than the initial EMF. This addition of EMF's might become a serious matter, as tending to ruin insulation on short lines, but is obviated by throwing the line out of balance. To Professor Dutbar is due the credit of first pointing out its possibility.

We have now examined the main features of polyphase circuits, and can go on to the consideration of some of the practical questions that arise in the discussion of any particular case. The voltage of transmission is probably the first question, and it is plain that the higher the voltage used, the less the copper necessary; but it is limited by various practical considerations. The generator EMF is, of course, limited by the construction of the machine, as to whether space permits of more or less insulating material. This can, however, be raised for transmission purposes to any voltage required by interposing step-up transformers between the line and generator. For any high pressure these transformers are filled with oil, which has a high insulating value, and has the advantage *that if a spark does jump at any time, the oil flows* back, so that the transformer is not permanently injured. On the lines a pressure of 10,000 volts is quite easily handled, the insulators being large, with plenty inside surface, and the copper can be bare. At the other end of the line the voltage can either be reduced at once to that required at lamps or motors, or can be reduced first to a convenient distributing voltage say 1,000 or 2,000 and then be reduced to *the lamp or motor* voltage. It should, however, be borne in mind that each such raising or lowering of voltage introduces an appreciable percentage of loss into the general calculation. For instance, if a large step-up or step-down transformer have an efficiency of 98, then the loss in a pair is 4% due solely to C²R, leakage, and hyteresis, without taking into account that loss due to the lag introduced by the induction of the coils. Another question to be settled is "what frequency of EMF shall be used?" and this is one that I do not think receives sufficient consideration. *If we look for a moment at the expressions for hysteresis, induction and capacity,* we shall see that all these losses vary directly as the frequency. It would appear therefore that it would be very advantageous to reduce the frequency as much as possible. The reduction of frequency, however, has the counter-balancing disadvantage that it renders necessary the use of larger, heavier, and therefore more expensive apparatus, and that if (the current) is to be used for lighting, less than about 40 or 30 alternations *per second is appreciable to the eye in incandescent lamps,* and less than about 50 in arc lamps. If it is to be used solely for power purposes then this limit is taken away, and the actual decision should be made on the basis of whether the enterprise can better afford to waste power in the lines, or to increase its capitalization.

A subject of such interest as "Electrical Transmission" can hardly receive adequate treatment in the limits of a short paper, and I have already trespassed considerably on your good nature, but I desire to very briefly touch on those preliminary considerations which should shape the policy of any such enterprise, and the importance of which appear to be not duly recognized. The engineering features of any enterprise should be not only influenced, but actually decided by commercial considerations. Electricity is not the object, but the means; the object being to make money by the sale of power. The engineering must be decided by the commercial value of this power. *Assume a water power ten miles distant from a manufacturing* town, the energy of which is to be electrically transmitted. What loss is to be allowed in the lines? Can we afford to lose a good deal in the lines, transformers, etc., and so reduce the size of our conductors and consequently our construction expense? or would it be better to keep the loss as low as possible, and save the power for sale? Engineering says you can make your loss as little or as great as you please, but commercial *considerations* say *if power is more* valuable than money it will pay to save all the power possible for sale, even at the expense of heavy conductors. If there be a large demand for power at a high figure, and the source of power is limited it is best to waste as little as possible; if the supply be very large and the demand small, it may, on the contrary, be best to waste much in the lines, in order to reduce the copper cost. Here again commercial considerations are paramount, for it is obvious that if much power is to be lost in the line the generators and water wheels must be sufficiently large to furnish this waste power, and therefore cost more money, and a balance must be struck. Once a decision has been arrived at as to the loss allowable, then engineering considerations must settle as to whether it shall be mostly ohmic or mostly inductive, and here comes in the question of frequency. The efficiency of machinery is not sufficiently considered, and yet has a most appreciable influence on operating costs. The conditions under which motors operate are generally such that, although they may be called *upon for a comparatively large* output now and then, their average load, the work they are required to do most of the time, is greatly less than the above maximum. Consequently it would appear that their efficiency at such average load is of more importance than their maximum load efficiency. If therefore, in the above case, the supply is limited and the demand great, the half load efficiency of the entire plant assumes great importance.

I think the above considerations, and others that will no doubt occur to any thinking person, will show conclusively that no transmission scheme should be undertaken blindly. A should not necessarily use 10,000 volts because B does; nor should he follow the engineering features of B's scheme simply because B has found them suited to his conditions. Every case should be considered on its merits, and the results worked out independently. A little or more or less loss does not mean simply a little less or more copper, it means less or more power to sell, larger or smaller generating plant, it means less or more profit. In every enterprise there is a certain combination of machinery, lines, etc., that will secure the maximum of efficiency with the minimum of expense, and this will not be attained by either regarding it from the purely commercial standard of getting the cheapest, or from the purely engineering standard of putting in the scientifically best, but can only be attained by combining the two and by clearly recognizing the fact that solid commercial principles enter into engineering as much as into pure business.

METERS.

By Jas. Milne.

The subject of meters is probably the most important one in connection with central station lighting. It has received considerable attention, no doubt, from a few, but I question very much if it has received that attention which it deserves. Every manufacturer, we know, claims to have the best meter on the market,

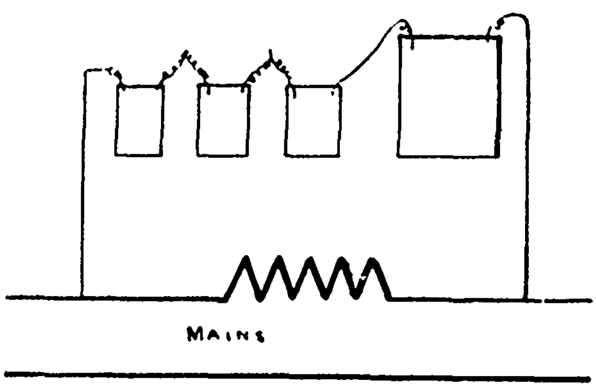


FIG. 1.

correct throughout its entire load. We know also that any manufacturer can quite readily get up a meter to stand a test for a day or so in some laboratory, and be correct, but this, I claim, is of very little use as far as everyday work is concerned. The object of this paper is more to touch on some of the more important meters in practice, making comparison with some of these meters from actual results.

It is sixteen years ago since Edison brought out the incandescent lamp, and we find, according to the records, that even before he had his lamp perfected he was busy on some kind of a meter to accurately determine the consumption of the current. No matter what people say to the contrary, we owe to Edison's inventive genius the practical success of the continuous current. The idea of connecting lamps, motors and other translating devices, in multiple, was original with him; also the high-resistance lamp, the feeder system, and many other important details which tend to make electricity the most useful of all agents. To Edison also remains the credit of originating the meter. He not only saw, as far back as 1880, that there was to be a great future for electricity, but he also saw that to make it a commercial success, as applied to lighting, etc., the current must in some manner be supplied on the meter basis and sold accordingly, just the same as gas or water.

The correct way to sell current is certainly by meter; this is the experience of every one. Satisfactory arrangements can at times be made with certain customers where the average consumption and the average run can be arrived at with a certain degree of accuracy, but even in cases of this kind it is advisable to put on a meter.

Edison's first patent was taken out in 1880, and the meter, with some modifications, is almost identical with the Edison meter of to-day. It is shown in Fig. 1. It consists of several cells in series, and the amount of current passed is measured by the amount of transfer of metal from one plate to another. We see that all the current does not pass through the cells. If the resistances are known of the two branches, we can easily determine the relative amounts of current flowing through each. For instance, if we have a derived circuit, one branch of 1 ohm resistance and the other 2 ohms, we see at a glance that whatever current is flowing in the circuit will divide into three parts, two of which will flow through the one having least resistance, and the remainder through the other. If a copper or zinc voltameter be placed in the 2 ohms branch and we find a certain deposit on one of the plates, the cathode, then we must know that had there been a similar voltameter in the other branch (1 ohm) there would have been twice the deposit. It is not necessary, however, to put in this second voltameter to arrive at the result, for as long as we know the ratio of the resistances and the electrolytic cell put in any one of the branches, the total current passed through can be accurately arrived at from the deposit in that cell.

One of the laws of electrolysis is that "the amount of chemical action at all points of the circuit are equal to each other." This does not mean that the same current passing for the same length of time through different solutions will decompose equal weights of the metals contained in these solutions, but that the weights of the metals so decomposed will be chemically equal; that is, the weight will be in direct proportion to their chemical equivalent. For those who have not studied the "chemical effect" of the current, it might be advisable to explain some of the terms: The weight of one atom of hydrogen is taken as the unit (1), and that of copper is 63 i.e., 63 times heavier than an atom of hydrogen; but in chemical combinations one atom of copper is worth, or replaces, two atoms hydrogen, hence the weight of copper equivalent to one of hydrogen $= 63 \div 2 = 31.5$. This is called the chemical equivalent and is = atomic weight ÷ valency. The atomic weights of copper, zinc, nickel and silver are 63, 65, 59 and 108 respectively, and their valency 2, 2, 2, and 1 respectively, therefore the chemical equivalents are 31.5, 32.5, 29.5 and 108 respectively. Another term very much used in these calculations is the "electro-chemical equivalent," and this is equal to the weight of a substance in solution decomposed by the passing of one coulomb. If we know the electro-chemical equivalent of any element, and we also know the chemical equivalent of the other metals, the electro-chemical equivalent of these metals can readily be calculated.

It has been determined experimentally that 1 coulomb, passing through water, will liberate .000010352 grams of hydrogen, and as the chemical equivalent of copper is 31.5, therefore the electro-chemical equivalent will be = chem. equiv. × .000010352 = .000326088, and so on, for the rest of the metals. If we suppose the four cells in Fig. 1 to be copper, zinc, nickel and silver, we have a deposit 117.5 grams in the copper, 121 in the zinc, 110 in the nickel, and 402.5 grams in the silver voltameter, we can determine the ampere-hours.

Let C = current, y = electro-chemical equivalent, t = time in second and M = *mass* decomposed, then $C = \frac{M}{yt}$, or taking the copper voltameter, we have $C = \frac{117.5}{.0003261 \times 1\ \text{hour}} = 100$ amperes flowing for one hour or equivalent thereto. If the current in each

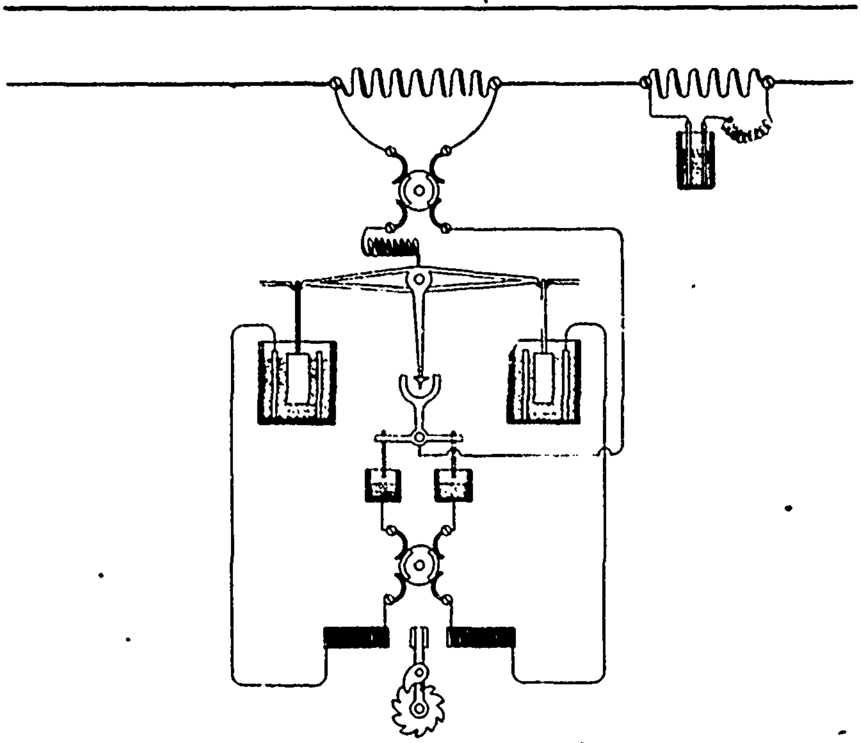


FIGURE 2

of these four cells calculates out to be the same, then we must come to the correct conclusion that 100 amperes must have passed for one hour, or equivalent thereto. If only one of these voltameters *had been in the circuit and the resistance remaining the* same, we would have had exactly the same results. In the above example of a derived circuit composed of 1 and 2 ohms, we place the copper voltameter in the 2 ohms branch, and we find as above, 117.5 grams deposit, which represents 100 ampere hours; then as this only represents one-third of the total current passed through the circuit, therefore 300 ampere hours would be the correct reading on this particular meter.

With this preliminary and elementary explanation we are now in a position to more clearly understand the chemical meter and also to follow up some of those as made by Edison. It will, however, be entirely out of the question to treat on all the meters as made by him, so we will simply deal with those having more of a direct bearing on the meter as we have it to-day.

As far back as 1881, it occurred to this genius that in order to satisfy the public, if such a thing were possible, the meter should be arranged that the customer could read it for himself. We therefore find, fifteen years ago, a self-recording chemical meter exhibited at the Paris Exhibition. Its principle is shown in Fig. 2. The resistances are so arranged that only a small known quantity of the total current will pass through the electrolytic cells. The meter as shown would not record, so much like the recording meters of to-day, but if we tilt the balance-beam shown above, this kicks the beam below in the opposite direction, making contact through the mercury cup and sending a current round an electro-magnet, which registers one on the counter. Current now flowing through the cell on the right of the balance beam was tilted so that the left end was down, and after a certain quantity of current has passed the cathode (the weight on the beam) will get heavier and in time throw the beam the other way. When it is swinging, contact is broken in one mercury cup and made in the other, bringing the electro-magnet on the other side into play, causing another unit to be registered on the counter. The same action takes place in this cell as in the other, and every kick, or second kick, according to the arrangement of the mechanism, is registered on the counter.

In the circuits leading to the cells reversing commutators are placed so that at the end of every month or so the direction of the current can be reversed, thereby reversing the deposit. By this arrangement the plates could be made to last for an indefinite period. In one description I have of this meter it states that the commutating devices were so arranged that when metal was being deposited on one plate the other was being dissolved, or when one plate was getting heavier the other was getting lighter by an equal amount at the same time. Take this style of a meter and we will suppose copper plates in a sulphate of copper solution are used, and that the ratio of resistances are 1:99, and we will take it for granted that the beam tells at every .05 grams, and that 94 is registered on the counter. The total deposit is 4700 milligrams, and from this quantity the total current has to be determined. In calculating same out, we find that C in the high resistance amounts to 4 amperes for 1 hour or 4 amp. hours. But this represents only what passed through the circuit in which the voltameter was placed $\therefore 4 \times 100 = 400$ amperes for 1 hour would represent the total current passed through the whole circuit when the resistances are arranged as 1:99. We might adopt a constant of 4.277 to bring the reading ampere hours.

In this same figure then is one very important detail in connection with same that may be overlooked, yet it shows, to my mind at least, Edison had little faith in this, and I might confidently state, in any other self-recording apparatus. I refer to the electrolytic cell in series with the recording device. I have not the least doubt that this recording meter was as nearly perfect, and probably more so, than the majority of recording meters in use to-day, yet we see that fifteen years ago he came to the correct conclusion that recording devices were unreliable.

It is certainly remarkable when we think over this; we are in precisely the same predicament as we were at that time; we have

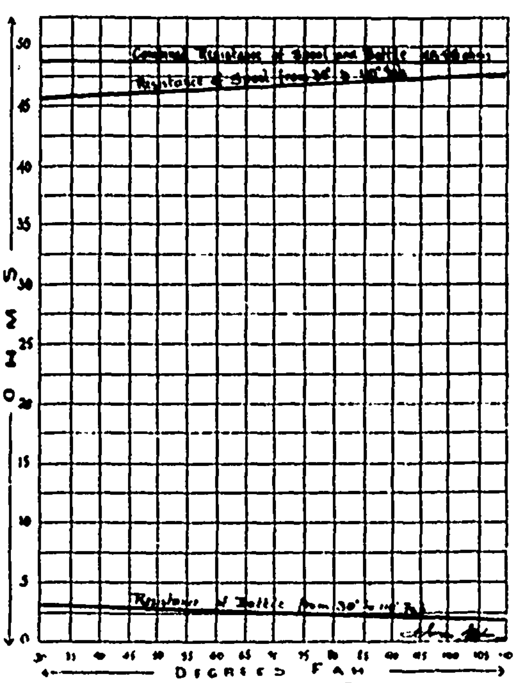


FIGURE 3

to do exactly the same thing to-day, viz: put in an Edison chemical meter in series with all these recording coulomb and watt-meters of the motor type if we wish to get at the correct consumption. History does not say whether this type of meter was ever pushed or no, but that is immaterial as the main point I wished to draw your attention to was the cell in series with the recording mechanism. Several other recording devices, including motor meters, are to be seen among his patents; in one the current operated a pointer which made a diagram on a sheet of paper placed on a revolving cylinder, the area of which, when measured by a planimeter gave the consumption. In a meter of this kind the maximum and minimum loads, a very good point indeed, could easily be traced, a thing which cannot be done with any meter we have to-day.

In the early Edison meters copper plates were used which did not give very satisfactory results, and it led the inventor to try various metals, among which was amalgamated zinc immersed in a zinc sulphate solution. This gave excellent results and is used in the meter of to-day with perfect results.

Everyone is aware that the resistance of copper wire increases as the temperature increases and if we wish to keep the resistance of a certain circuit constant irrespective of temperature changes something must be inserted in this circuit which has an equal and opposite effect to that of the copper, that is to say, if we have a circuit of 50 ohms R at 60° Fah., composed of a spool of wire 46 ohms, and something else of 4 ohms, and if the temperature rises so that the spool now has 47 ohms, then the R of this something else must be 3 ohms if we wish to have the total R constant at 50 ohms. In the Edison meter the resistance of the electrolytic cells decreases as the temperature increases, and to make up for the decrease in resistance a compensating spool of copper wire is put in series with same, which has an increasing resistance equal in amount and opposite to that of the cell. In Fig. 3 it shows the resistance of the "bottle" or electrolytic cell and also that of the compensating spool. We see that the cell decreases and that the spool increases for increased temperature and that the two combined give us practically a straight line. The resistances are calculated from 30° to 110° Fah. or a range of 80° which is considerably more than is ever met with in practice. In the

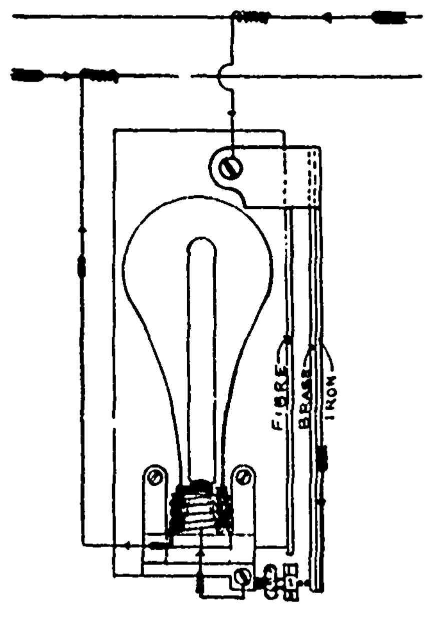


FIG. 4

Edison meter the branch of low resistance is made of German silver and is called "shunt". The resistance of German silver varies .02 of 1% for every 1° Fah. In the smallest size of meters the shunt has a resistance of .04 ohms at say 60 and we have no compensating devices, therefore for a rise in temperature we must have an increase in resistance, and if we have an increase in resistance an error must be the result. The greatest percentage of the error will be in the smallest meter, therefore we will just calculate what the error amounts to. At 60° the shunt is .04 ohms, at 105° it is .04040 ohms and at 30° it is .039733 or a difference between 30° and 105° of .000667 ohms making the maximum error that can come into effect less than 2% or to be exact 1⅔ or less than 1% above and less than 1% below.

Taking the conductivities we find that if 100 amperes are flowing in the circuits .08161225 amperes go through the bottle at 60°. At 105° there are .082248 amperes and at 30° .08109 which shows that between 60° and 105° we have less than 1° and between 60° and 30° we have .6% as being the amount of the error.

Where meters are generally located the temperature in the summer rarely exceeds 70°, and in the winter never below 40°. Therefore in actual practice from 25 to 30 degrees would represent the greatest variation of temperature, which gives us .0400888 ohms as the R of the shunt at 70° = .2% error and .039823 ohms at 40° = .5% error, or in other words the meter in the summer time would be one-fifth of 1% fast, and in the winter about two-fifths of 1% slow, making an average of about one-tenth of 1% slow for the whole year. In the larger sizes this loss decreases to almost nothing. Therefore for the variation in temperature due to the heating of the current or atmospheric variation we see that the percentage of error is practically nothing, so small that it may be entirely neglected.

So far we have assumed the lowest temperature as per Fig. 3 to be 20° Fah., but there may be places where the temperature goes considerably below this. These places are very exceptional however. The zinc sulphate freezes at 27° Fah. and some means must be taken to prevent its freezing. In Fig. 4 is represented the arrangement as put in the present meter to prevent the solution from freezing. It consists of a strip of brass and steel rivetted together and fixed at one end, the other being free to move. It is called the thermostat. When the temperature gets very low the brass contracts more than the steel and causes the strip to curve making contact with the terminals leading to the lamp, which on completing the circuit lights it. When the temperature rises again the compound strip straightens and the circuit is broken.

A patent was filed in 1881 covering this temperature regulator *which at that time consisted of a resistance coil acting as the source of heat.* Some few months later we find still another method of preventing the solution from freezing. This is shown in Fig. 5. It consists as in the former of the compound strip

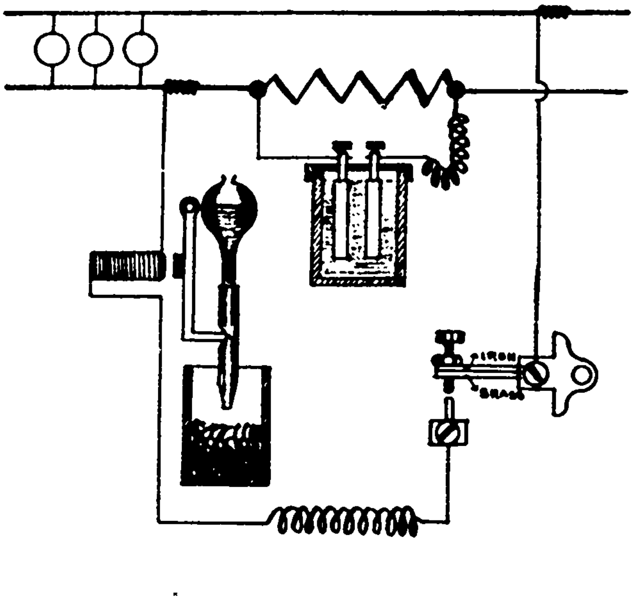
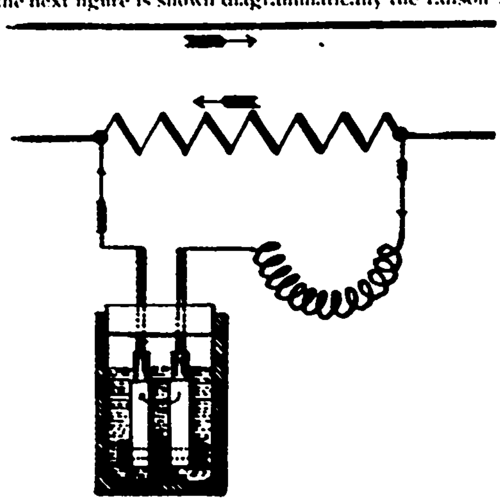


FIG. 5.

which makes and breaks the contact. When contact is made current is sent round the electromagnet, attracting the armature to which is attached an arm operating a valve which when open allows water to run into the cell underneath containing quicklime, the mixture causing heat. I might state that here in Toronto the temperature is so uniform(!) we have no thermostat in any of our meters although they are all adapted for them.

In the next figure is shown diagrammatically the Edison 2 wire

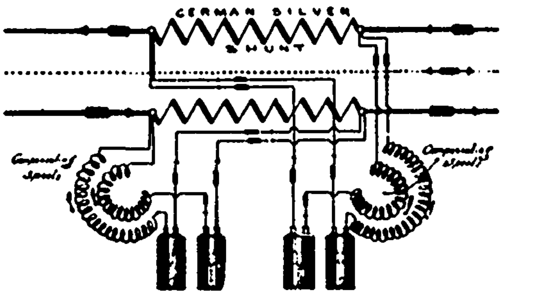


EDISON 2 WIRE METER

FIG 6

meter which, as has already been stated, consists of a German silver shunt in multiple with a compensating spool in series with it the electrolytic cell. The connections, you'll observe, are simplicity simplified. In Fig. 7 is shown a 4 bottle 3 wire meter, and is simply two 2 wire meters in the one box. The object of having the two cells in multiple is that one bottle acts as a check on the other. In a meter of this kind we have practically four 2 wire meters, the two shunts being common to the 4 meters. If we wished to have the same check with 2 wire meters on a 3 wire sytem of any other make, there would have to be 4 of these.

In practice we find that the transfer of zinc in each pair of bottles on the same side of a 3 wire system in very many cases agree exactly to a milligram, and the maximum variation never exceeds a few milligrams. This shows without doubt



EDISON CHEMICAL 3-WIRE METER

FIG 7.

the great accuracy of the meter and when we have a reading on a meter of this kind and the bill sent out accordingly and the customer swears by everything holy that he "never turned the lights on," you are perfectly safe in assuming that if he did not turn them on then some one else did it for him. The customer says one thing and we have two meters silently testifying the other way. Which of the two are you to believe? The meter by all means.

The following table gives the sizes and other particulars of the meters as made to-day.

THREE WIRE.

Size.	Capacity.	R. of Shunt in ohms.	R. of spool at 60.	R. of bottle.	Capacity in .5 amp. lamps
1	10	.04	46.46	2.5	40
2	20	.02	46.46	2.5	80
4	40	.01	46.46	2.5	100
8	80	.005	46.46	2.5	320

TWO WIRE.

Size.	Capacity.	R. of Shunt in ohms.	R. of spool at 60.	R. of bottle.	Capacity in .5 amp. lamps
1	10	.04	46.46	2.5	20
2	20	.02	46.46	2.5	40
4	40	.01	46.46	2.5	80
8	80	.005	46.46	2.5	100
16	160	.0025	46.46	2.5	320

You'll observe that the R of the shunt varies while that of the spool and bottle remain constant for the different sizes.

It has been found, experimentally, that one ampere passing for one hour will remove from one zinc plate and deposit on another when immersed in a zinc sulphate solution 1.225 grams or in other words, the electro chemical equivalent is .00034 grams. One ampere need not flow to deposit this quantity. 10 amperes for 6 minutes or .25 amperes for 4 hours would give exactly the same result. From this electro-chemical equivalent, we can determine what the deposit will be for a certain quantity of current and also from a given deposit the quantity of current passed. For instance, we have a current of 100 amperes passing for 3 hours, what would the deposit be if zinc plates were used? We find it is 367.200 grams=.8lbs. Here we have taken all the current flowing in the circuit as going through the electrolytic cell, which if it did in practice would give us an enormous consumption of zinc. Cyt=M=913.104 grams or 2lbs per h.p. per hour at 1 volt, which gives us the formula $\frac{2}{E}$lbs per h.p. per hour as being the consumption of zinc when E E.M.F.

In the above table we see the resistances are so proportioned that for every ampere passing for one hour in the smallest size .001 grams will be deposited on the plate, that is the resistances are as .04 : 48.96 or 1 : 1224 which gives us exactly 1 milligram deposit for every ampere hour.

Let us now see how the amount of consumption of zinc for a given term or the quantity of current from a given deposit are computed. We will take the deposit as .1 gram or 100 milligrams. In the smallest size of meter when the resistances are 1 : 1224 we saw that 1 milligram represents 1 amp. hour, and also if the resistance were as 1 to 2448 one milligram would represent 2 ampere hours, and so on up to the largest size of meter when 1 to 19584 is the ratio of the resistance. One milligram 16 amp. hrs. Therefore for the latter size of meter 100 milligrams would represent 1600 ampere hours. Taking it another way we have a current of 160 amperes flowing through the circuit. What will be the deposit per hour? The resistances are as 1 : 19584.·.

$\frac{1}{19585}$ of 160 amperes will flow through the bottle which gives us .00817 amperes for 1 hour .00817×.00034×1 hour 10 milligrams. 3ut we say that 160 amperes were flowing, therefore to arrive at the total ampere load this reading will have to be multiplied by 16.

In the table the meters are numbered 1, 2, 4, 8 and 16, and the one we have calculated is No. 16, and we have just determined that the deposit has to be multiplied by 16 to bring it to the same basis as a No. 1 meter, i.e., 1 milligram 1 amp. hour, or in other words the meter number is the constant of that meter.

On referring to Fig. 7 we see two bottles in multiple. The average deposit is what is taken in these meters which total deposit ÷ number of bottles in multiple.

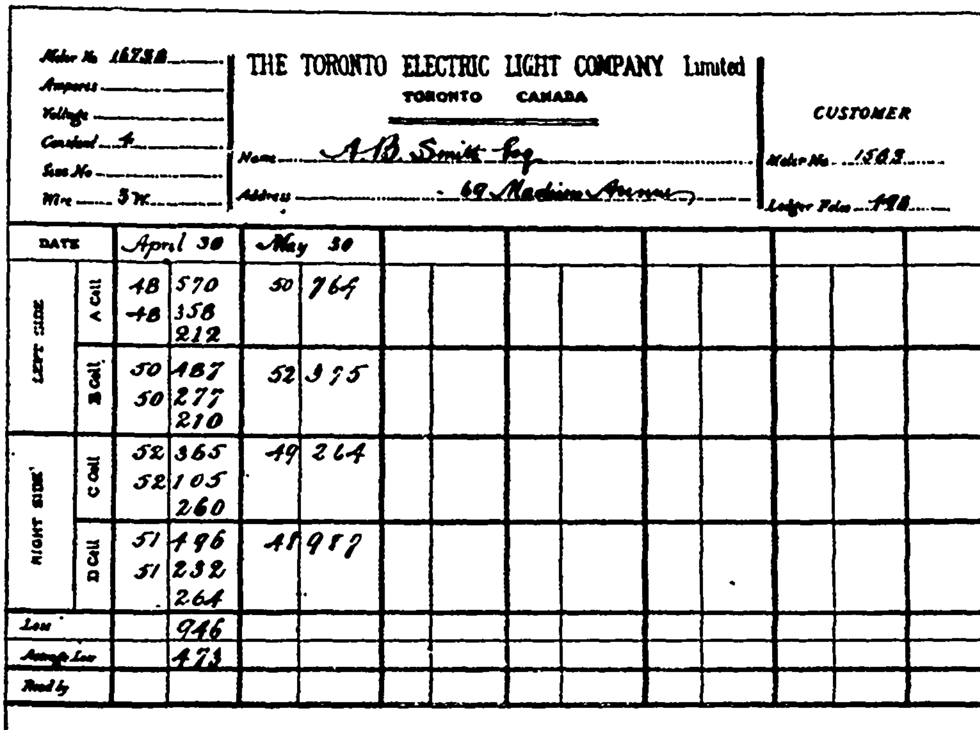
The loss in an Edison meter is very small, in fact so small that it may be neglected.

The joint resistance of the shunt and spool of a No. 1 meter is .039957 ohms, say .04, therefore at full load the loss would be 4 watts and only when meter is in actual operation, that is when current is being used. If this meter were placed on a 120 volt circuit it would mean 1/3 of 1%, and if placed on a 240 volt circuit 1/6 of 1%, and 1/12 of 1% on a 500 volt at full load.

As a matter of fact the meters are never put in so as to run up to their full capacity continuously, so that we can safely reckon at the outside the load as being 1/4 to 1/2 their rated capacity, which makes the loss on a 120 volt circuit at 1/4 load .08 of 1%, and at half load .16 of 1%.

The percentage of loss in all sizes is the same if calculated at the same percentage of load.

It might not be out of place to show the ordinary meter form as used in Toronto, which is suitable for chemical and watt meters, and the method of making up the bill from the meter reading is very simple. In Fig. 8 we see that A. B. Smith's reading from April 30 to May 30 is 473×4 milligrams, or 1891 ampere hours, and if the bill is rendered in lamp hours, and if each lamp takes .5 amperes then the deposit × 2 gives the bill in cents if the rate is 1c. per lamp hour, or $37.84.



Meter No. 16738
Amperes
Voltage
Constant 4
Size No.
Wire 3W.

THE TORONTO ELECTRIC LIGHT COMPANY Limited
TORONTO CANADA

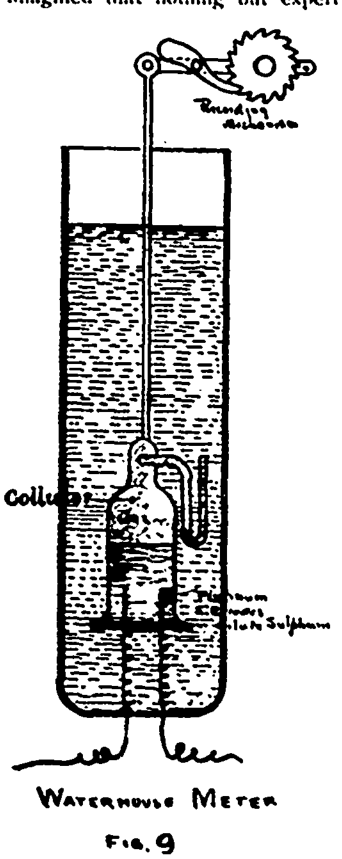
Name A. B. Smith Esq.
Address 69 Madison Avenue

CUSTOMER
Meter No. 1583
Ledger Folio 198

		April 30		May 30	
Left Side	A Cell	48 / 48	570 / 358 / 212	50	764
	B Cell	50 / 50	487 / 277 / 210	52	375
Right Side	C Cell	52 / 52	365 / 105 / 260	49	264
	D Cell	51 / 51	496 / 232 / 264	48	987
Loss			946		
Average Loss			473		
Read by					

Fig 8

Some have imagined that nothing but expert chemists can handle the Edison meter and that its cost of operation and maintenance is high. This is entirely wrong. The meter department of any central station requires at least intelligence and if run without this will very soon become unprofitable and unreliable. In a station where there are about 1500 to 1800 meters the cost of maintenance, including all chemicals and the reading of same does not exceed 70c. per meter per year.



WATERHOUSE METER

FIG. 9

THE WATERHOUSE METER.

This is a recording electrolytic meter which was brought out some two or three years ago in England and deserves mention in this class. I have not had practical experience with it, but I am of the opinion that it should give satisfactory results. Its construction is shown in Fig. 9, and in Fig. 10 is shown the connections of same. We have here the shunt as in the Edison, also the compensating spool. The mechanical part consists of a method of recording the volumes of gas produced by a small portion of the current used by the customer. Gas is accumulated in the collector and the registering mechanism indicates the number of times this has been filled. The operation is very simple and is as follows: When a certain quantity of gas is accumulated it forces the fluid down the U shaped tube until it comes to the bend, and just as soon as it comes to this bend it immediately starts up the other leg and escapes. It is then filled up with the liquid and descends by gravity for another charge of gas. Pure water is used for refilling the cells every 3 or 4 months. This meter is very easily calibrated and is a coulomb meter, registering in ampere hours.

The two electrolytic meters mentioned are only used for continuous current, but there is one called

THE LOWRIE HALL METER

in which the same principle is used to measure alternating currents. In the secondary circuit a storage cell is placed in series with the electrolytic cell and it is taken for granted that the alternating current does not deposit metal, therefore the transfer from one plate to the other depends on the conductivity of the

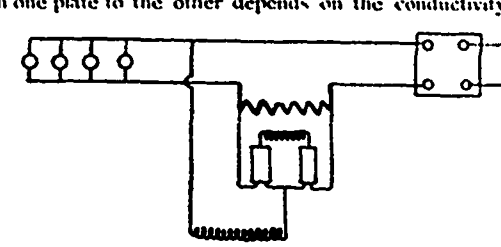


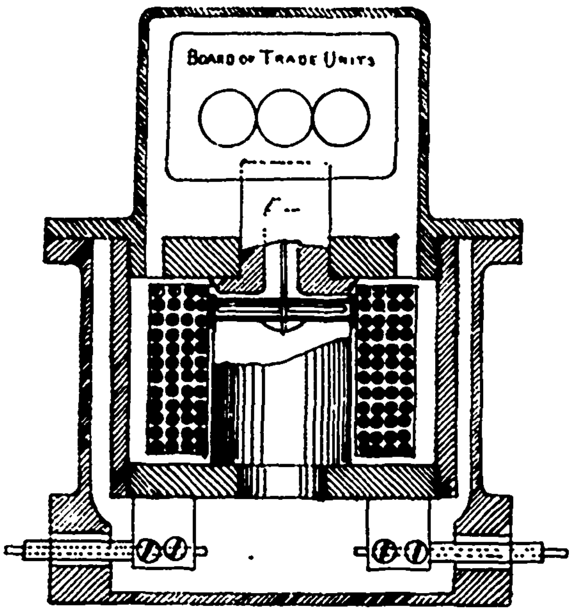
FIG 10

circuit, i.e., the number of lamps turned on. The total current going through the circuit passes through the storage cell, and if no lamps are turned on no current from the accumulator will flow through the voltameter, and if the lamps are turned on current will flow from the cell to the voltameter causing deposit, therefore the deposit will be a measure of the conductance from which the lamp hours can be arrived at.

We will now take up motor meters, and in this we have an endless variety. It would simply be out of the question to touch on them all, so we will just take up the most important and treat on them briefly. In this kind of a meter there are a few advantages over those we have already described, but the disadvantages more than offset the advantages. It has been claimed by some that they (some of them at least) require no attention. This is, as far as my experience goes, incorrect, for I find that motor meters require more attention than any other form, either chemical or clock. Nearly all of them consume energy when not recording, that is when no power is being used by the consumer; none of them will record on very light loads—if they do when just installed, they are not so sensitive afterwards.

There are, however, some very good recording motor meters, if we overlook these disadvantages, among which might be mentioned the Ferranti and Perry in England, the Shallenberger, the Duncan and the Thomson recording meters.

The Ferranti meter is shown in Fig 11, and is an ampere hour

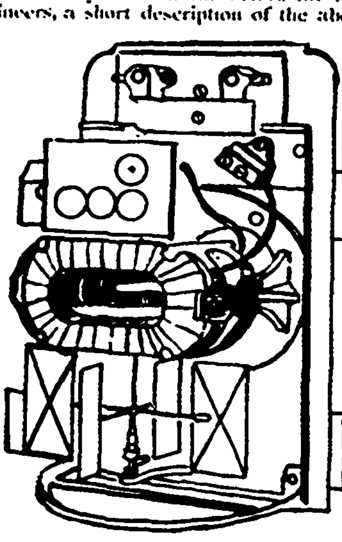


FERRANTI METER

FIG. 11

recorder. If a current is passed through a fluid in a magnet field, this fluid tends to move in a direction perpendicular to the direction of the current and also to that of the field. It is on this principle that this meter depends. Current enters at the centre of the mercury trough and leaves at the rim and in so doing gives motion to the mercury, the motion is communicated to a small aluminum fan which is connected to the recording mechanism. It is adapted for continuous and alternating currents.

In a paper read by a Mr. Dicks before the institution of Electrical Engineers, a short description of the above and following



SHALLENBERGER METER

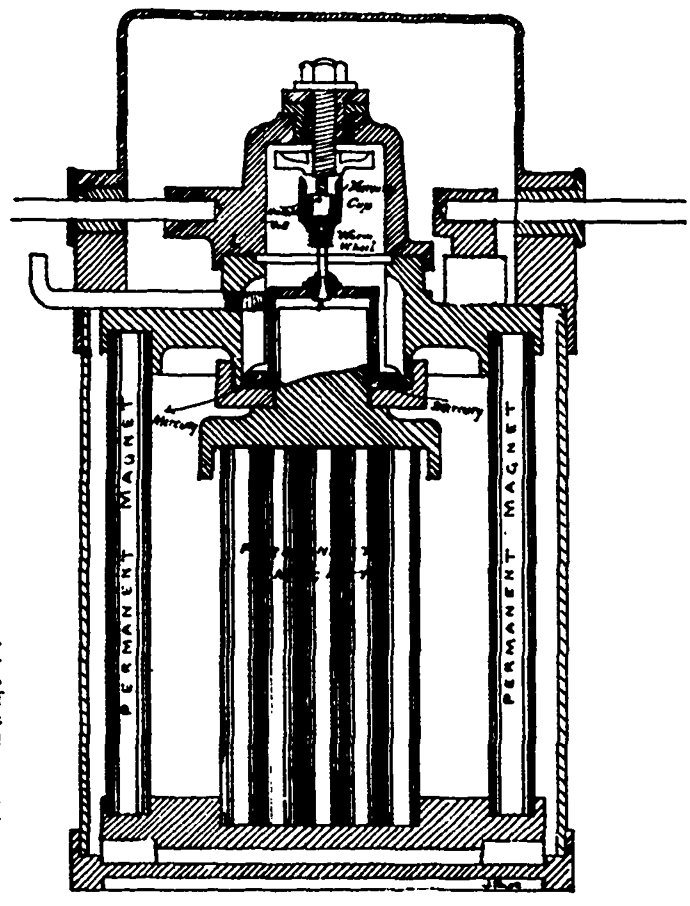
FIG. 13

meter is given which, should any of you wish to follow them up, will prove interesting, I have no doubt.

If current is sent from one end of a cylinder (in a magnet field) to the other the cylinder will rotate, and this is the principle of the Perry meter shown in Fig. 12. Current is admitted to the mercury dish shown at the bottom edge of the inverted copper cup which plows up the sides and leaves by the nickel rod at the top. Friction is reduced to a minimum. The speed of rotation is very slow and the meter will register very small currents in some of the larger meters, say 60 amperes; it will start up with .1 ampere.

The Shallenberger meter is shown in Fig. 13, and is intended for alternating currents. It has been very successful and a large number of them are in use. It consists of two coils, one carrying the main current and the other is a closed coil. A rotary magnet field is produced by an induced current in this closed coil which drags the iron disc around. No brushes or commutator are required; the disc has no electrical connection whatever. The retarding motion is effected by an aluminum fan fixed on the same spindle as the disc. It is an ampere hour recording meter and consequently the speed is directly proportional to the current. The calibration depends on the angle of the closed coil to that of the main coil.

The Duncan meter, of the Fort Wayne Co., has also made a good record, and like the above has neither commutator nor brushes. The armature is an aluminum cylinder and the closed secondary is made of several copper punchings. This meter



— PERRY METER. —

FIG 12

depends on the repulsion of a closed secondary from its primary. The primary coils are in a series with the lamp circuit. The retarding effect is obtained in the same manner as the Shallenberger.

Probably the most important of all these motor meters is the Thomson recording watt meter.

One of the advantages claimed for this meter is that it is adapted for continuous and alternating currents. This may be an advantage and it may not. In so far as we have meters for alternating currents of a simpler design, it looks to me as if it would be better and cheaper to have the separate meters. This is more a matter of opinion, however. In Fig. 14 is shown diagrammatically the Thomson watt meter. In the armature circuit is placed a high resistance coil, generally placed in the bottom or back of the meter and part in the field, the object of this latter part being to produce a field of sufficient strength to overcome the friction of the moving parts, brushes, &c., and it is perfectly clear that this current must flow whether current is being used by the consumer or not. The copper disc rotating in a permanent field acts as a drag, just the same as the little fan in the former meters, by generating an E M F. This E M F is proportional to the speed, therefore the retardation is proportional to the speed and the speed is proportional to C × E; therefore, the speed resulting from this is proportional to C × E, i.e., the power at that particular time.

Regarding the practical working of this meter, let us now devote a little time to same. The conditions in which they are installed are precisely the same as the Edison, that is, they are placed in the basement and as near as possible to the service. Take the average installation and we find very few switches between the service and the meter. The current, as already stated, flows through the armature circuit 24 hours per day, and in a test made recently to determine this amount, it was found that .05 amperes flowed through. This looks a small quantity, but if we have 1200 to 1500 of these meters, it means 60 to 75 amperes to keep up this alone, and from which there is no return.

If the voltage is 120, and taking the cost of manufacture at 2c. per k.w. per hour, it means $1300 to $1700 annually, which is equal to 6% on $22,000 to $28,000. This represents one source of loss, but there are many more. Every one of these meters, and in fact, *nearly all recording meters will when new start with comparatively little current*, but after they have been in use for a time a different result is noticed. For instance, we have an installation

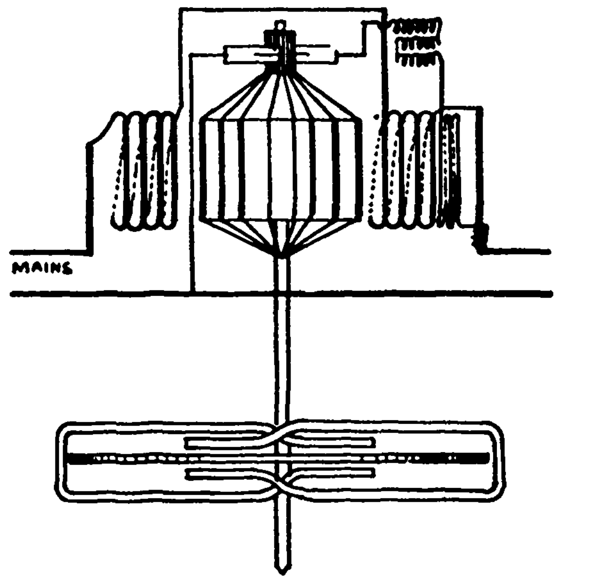


FIG 14.

of 500 lights on a 3-wire system—or any system for that matter—and we decide to put in a 120 ampere meter. *This meter has*, according to our Canadian law (God bless it), been duly tested, sealed, etc., and the company is permitted to install same. When first put in it is adjusted as nearly perfect as can be, and it is tried on a very light load. It does not start up with one light, nor two, nor even three; it takes between five and six lights to make it just move. It takes very good eyesight to see it make an attempt to rotate. At half load it appears to be all right, and the same at full load. In a couple or three months, when taking the reading for the second or third time, we try it to ascertain if it is still doing its work. At full and half loads everything indicates that the meter is doing its duty, but at the very light loads we find that instead of registering with 5 to 6 lights as it did at first, it takes almost 12 lamps to make it move. This is not an exaggeration. Although we have taken a large meter, yet I know the percentage is just the same for all the sizes of meters. What does this mean? What does it amount to at the end of the year? Let us take this actual example. Installation of 500 lamps running 2 hours per night for 5 nights per week, and before and after these hours we have from 10 to 20 lights burning three-quarters of an hour each, making a total of three and a half hours for the night.

As stated above it takes 12 lamps to make it record at all, therefore we may assume with perfect safety that the current for at least 8 to 10 lamps, say 8, has no registering effect on the meter. Now these lamps are burning 3½ hours per night, 5 nights per week = 140 hours weekly or 7,280 hours yearly. The total meter reading in this particular installation should be 267,800 hours, but as a matter of fact we only get 260,500 or 95.7% of what it should be, or a dead loss of 4½ per cent., which represents *in actual cash, if current is sold at .6 of a cent. per lamp hour* as we have it in Toronto of $43 on this particular meter alone. This may appear to you as being an aggravated case but I must say it is not; it is simply one out of quite a number and we are forced to come to the conclusion that *from this cause alone* the revenue of a company is 5% less than it should be.

There is yet another source of loss which is not applicable to the small stations. I refer to electric elevator work, or any work where there is a quickly varying load. Elevator work is without doubt the most unsatisfactory kind we have to contend with, and it is acknowledged by every one that these meters, in fact all meters, do not register the energy consumed. Those of you who have observed the action of a wattmeter or any recording meter on these loads must have been reminded of a lazy man, slow to start and quick to stop. In hydraulic elevators the amount of water is the same for all loads and if water is sold by meter or by the "feet run" of the elevator, it costs exactly the same to take up the empty car as it does to take up 4000 lbs. People have been content heretofore to pay for water in this manner and I cannot see why they should not be charged in much the same manner for the electric power. I think I am pretty safe in stating that the motor meter has nearly outlived its usefulness as far as elevator work is concerned.

We see therefore there are 3 great sources of loss.

First. Power consumed in the armature circuit.

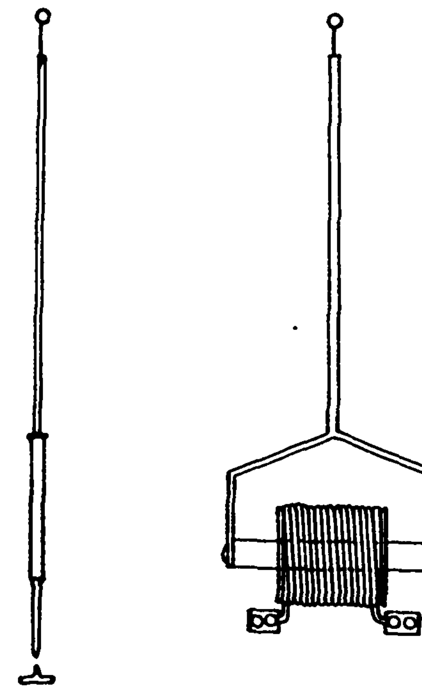
Second. Power not recorded at light loads.

Third. Power not recorded at quickly varying loads.

Now putting all these together we certainly have a very poor combination for any concern to be supplying current by meter measurement.

How do we find the Edison chemical or any other chemical meter under each and all of these conditions. *In this meter there are no moving parts, no friction to overcome, no armature circuit, therefore we have practically no loss*. The examples I have just given by the motor meter were proved to be incorrect by the chemical meter and as pointed out at the beginning of this paper that Edison did, 15 years ago, exactly what is being done to-day, viz., he put a chemical meter in series with the recording devices just to see how much the other was out. By actual measurement there is from 20 to 25% difference between the readings in elevator work. I have seen that new meter as got up by the Diamond Electric Co., of Peoria, Ill., *which records the energy*. *In a record of* a test sent out by them as made by Professor Jackson at the University of Wisconsin, it is practically correct at all loads and any frequency. As we have already stated these tests are very good in their way, but there is nothing like the test of actual practice and in this alone time decides.

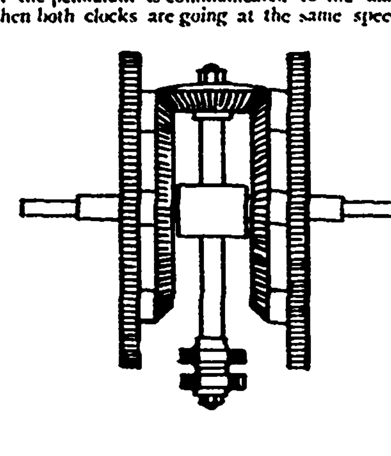
In the next class of meters the Aron figures as being the most important of all clock meters. We have several clock meters in this country but not one of them can in any manner compare with this one. It is adapted for alternating and continuous currents and is made as an amperehour or wattmeter. It is one of the most reliable meters in existence. It consists of two clocks, the pendulums of which are shown in Fig. 15—one keeping standard time and the other is retarded or



ARON METER.

FIG 15 J. Milne.

accelerated as the case may be by the action of a coil or coil carrying the main current in which the "ball" of the pendulum consisting of a permanent magnet oscillates. The principle of the gearing from which the motion of the pendulum is communicated to the dial is shown in Fig. 16. *When both clocks are going at the same speed the middle*



DIFFERENTIAL GEAR OF THE ARON METER.

FIG. 16

bevel wheel is turned around on its own axis, but if one is going faster than the other the middle wheel is turned around on its axis and also around on the axis of the spur gears. This motion is communicated to the wheels operating the pointers on the dials, and it is only where there is a difference in the speed of the clocks that the meter records. This meter possesses the great advantage of recording, no matter how how small the amount of current is.

In the next figure we show the principle of one of the clock meters that is used in this country to considerable extent. It is neither an amperehour or wattmeter, simply a time recorder, that is, it records the number of hours the current has been flowing in a circuit. It is called the "Pattee Lamp Hour Recorder." It consists of an ordinary clock in which is placed an electromagnet, which is so arranged that when current is turned on a spring is released which disengages the escapement wheel. It is extremely simple and not liable to get out of order. It is very applicable to places where there is a steady power such as arc lamps or motors with steady load. In a store where 10 arcs are required at the one time and the meter records say 200 hours then 200 ×

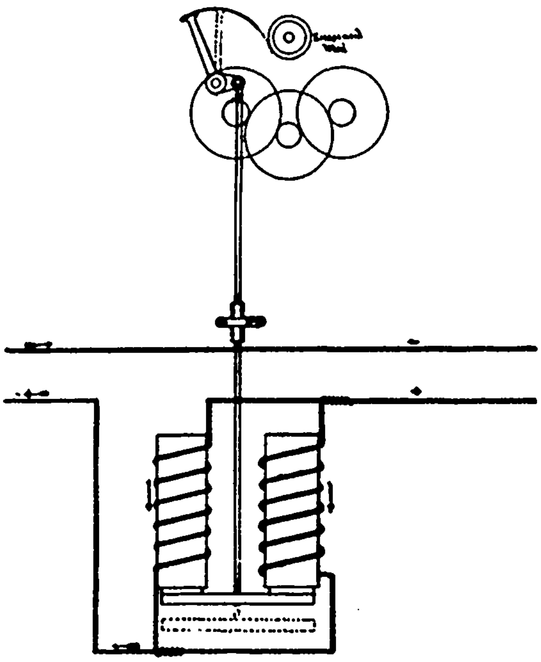


Fig 17

No. of lamps × rate per lamp hour = bill; or again if we have a motor say 6 h. p. average rate 6 c. per h. p. per hour, meter records 100 hours, we have 100 × 6 × 6 = $36.

With this meter, however, it is only an approximation as to the power; however its simplicity commends it.

Let us now sum up the advantages and disadvantages of the various meters.

The advantages of the Edison chemical meter are:

1st, Practically no loss.
2nd, No moving parts.
3rd, *Absolutely correct at all loads.*
4th, Will record the smallest possible amount of current.
5th, It is applicable to any pressure.
6th, Low first cost.
7th, Low cost of maintenance.
8th, Readily repaired.

The only disadvantage (if any) is that the consumer can't read it for himself.

Motor Meters:—The only advantage is that the consumer can read the meter.

The disadvantages are:

1st, Loss in overcoming friction in the moving parts.
2nd, Incorrect at light loads.
3rd, Incorrect at quickly varying loads.
4th, First cost high.
5th, Cost of maintenance high.
6th, Not readily repaired.

Clock Meters:

In the Aron type of meter we have the following advantages:

1st, Correct at all loads.
2nd, Will record the smallest possible current.
3rd, As a coulomb meter it is applicable to any pressure.
4th, Practically no loss.
5th, Can be read by the customer.

The objections to this meter are:

1st, Liability to stop recording if clock stops.
2nd, First cost high.

We therefore see as a practical meter the chemical meter is superior in every point, save one, and that is the customer can't read it for himself. Is this much of an objection? How many gas consumers read their meters? I know I am not very far out when I say that not over 2% ever wish to read their meters.

The Edison meter has been condemned by a certain class either through ignorance of its principle or prejudice and our Canadian Government have also seen fit to practically condemn it—probably not condemn it, but to curtail the growth of a meter that has no superior and very few equals.

It does seem strange to me that the Government should interfere the way it has done and more especially with the electrolytic meter when in the "Act respecting the units of electrical measure" in section b, lines 14 to 21 under the heading of "ampere" it states "as a unit of current the ampere which is .1C.G.S. units and is represented sufficiently well for practical purposes by the unvarying current which when passed through a solution of nitrate of silver in water and in accordance with the specifications contained in schedule on to this Act deposits silver at the rate of .001118 grams per second."

What does this mean? It means that they have practically adopted the chemical meter for determining the unit of current. In the Act it says the electro chemical equivalent is .001118 for a silver voltameter just the same as .00034 represents the grams deposited per coulomb in a zinc or .000305 for a copper voltameter.

It is immaterial whether they specify silver, copper or zinc, the principle is exactly the same, and it does look absurd on the face of it when the unit of current .1C.G.S. units is according to law laid down as above, yet in the same Act a meter on precisely the same principle is limited to the extent of the number of meters in use at the time the law came into force.

It may be argued that it is not the principle of the meter that is the objectional point but that it is not self recording, the law, of course, calling for "dials." If any consumer wishes to keep a faithful record of the number of hours he burns his lamps he is at perfect liberty to do so and if he does so conscientiously and the lamps of the efficiency they are said to be, or suppose then the bill rendered from the meter reading will coincide exactly to a cent.

Again, it has been claimed by some holding important positions that to be renewing the zincs is practically renewing the meter, that is supplying a new meter. Did you ever hear of such gross rot? What is the law on this point, it is "that the present number must not be increased and all new meters must be of the direct reading type," or words to that effect.

The Government has to raise a revenue, that is settled; the gas companies contribute a certain percentage of that revenue, the electric companies are their greatest competitors, therefore we can readily infer that any little obstacle that can be put in the way by such companies will be done so and it is very common property that this Act was the result of the gas companies.

May I ask "Where did the Government get hold of that definition of the ampere and also the voltameter specification? How are we to determine from this the alternating unit of current?"

Has the Government inspector created any better feeling between the companies and the consumer? Do consumers pay their bills with any better grace than before the law came into force? Do customers put any faith in this test? Are there any advantages to be derived from this test? If so, where?

The answer to the first three is in the negative, and the fourth in the affirmative, and to the last, I will leave it unanswered for the present.

Probably I have digressed from the line of these papers, and in returning to same I wish to again draw your attention to the advantages as enumerated above in the electrolytic meter.

Is there another meter in the market that can lay claim to the same?

OPERATING ENGINES WITHOUT A NATURAL SUPPLY OF CONDENSING WATER, OR THE CONTINUOUS USE OF INJECTION WATER.

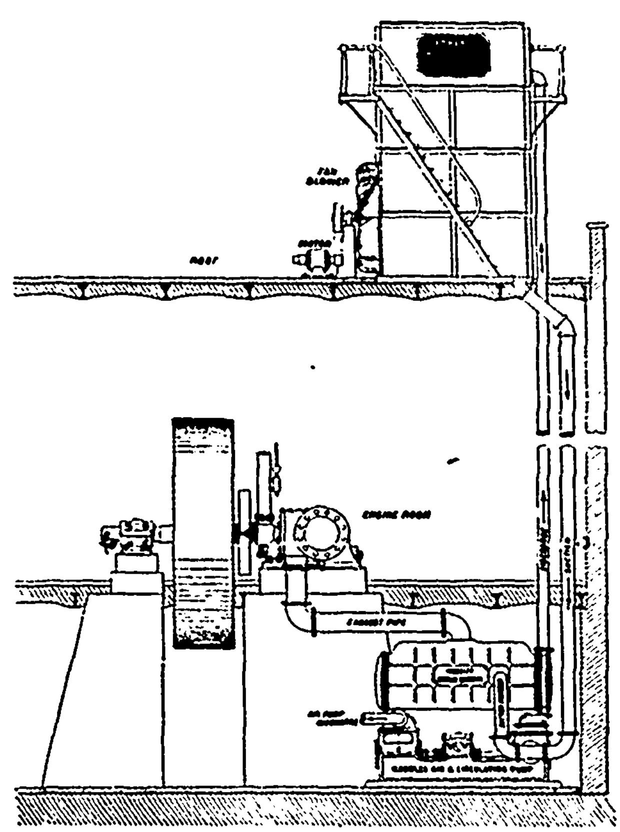
By E. J. Philip.

The subject is somewhat new, and information on it must be taken from the few plants that are now operated upon this principle. Like all other new departures in steam engineering, there is very much to be learned and studied before everything in connection with it is properly understood. In a paper of this kind we can only go into the leading points about it, as the subject is so large that a whole volume might be written on it to cover fully the whole ground. From observation throughout the country it is evident that the principle of running engines condensing is not as thoroughly understood as it should be, for we have many cases where there is a sufficient supply of water within reach, and still the engines are exhausting into the atmosphere. This perhaps because many think the expense of putting in and maintaining a condenser is greater than the saving would warrant. As an illustration, take an ordinary high pressure engine of say 100 h.p., using say 4 lbs. of coal per h.p. per hour and running 10 hours per day, the coal consumption would amount to two tons per day. The water consumption per h.p. in that case would be represented by 30 lbs. per h.p. hour. If a condenser is added the same power would only require say 22 lbs. of water, making a saving of 26 per cent. The total coal consumption for the year, running 365 days, would be 730 tons. If the coal can be put in for $3.00 per ton, the year's consumption would amount to $2,190. The cost of adding a condenser to such a plant, including the necessary piping, should not exceed $300. The cost of operating the condenser will be about 6% of the power of the engine, and is equal to $131. The interest on the condenser investment at 6% is $18, making a total cost of $149 per year to maintain and operate it. 26% of the coal account would be $569, from which deduct $149, the cost of operation, leaving a net gain of $420. This in many cases would make a dividend for the owners where there is none at present. In cases where the water for condensation is not procurable except at considerable expense, it can be used over and over again, and be cooled by air. The idea of cooling water in this way originated in Germany, and was applied for the purpose of cooling beer. The first cooling tower was filled by the branches of trees, or brush. The air used was only the natural current due to the warm water. This, of course, required a very large tower to get an amount of cooling surface to be effective, as the air current was necessarily very slow. The air is the cooling medium, and is indirectly the condensing medium. If you wet your hand and hold it in a current of air, you will feel a cold sensation, because the water is being evaporated and is taking up the latent heat of evaporation from your hand and the surrounding air. The specific heat of air is .2375, while that of water is unity.

If we depended upon the direct absorption of heat by a rise in temperature of the air, we would have to raise about 4 lbs., or 55 cubic feet, one degree, to absorb a heat unit. Consequently we would have to raise 1,000 cubic feet of air 55 degrees to condense 1 lb. of steam at atmospheric pressure. But when air is brought into direct contact with water, there is a cooling action due to evaporation much greater than is due to the elevation of temperature. When a pound of water is evaporated in this way, five times as much heat disappears as when a pound of water is raised from the freezing to the boiling point, and every pound of water so evaporated absorbs heat enough to condense one pound of steam. Now, by having an arrangement whereby we can pass a strong current of air over a quantity of water, favourably disposed to be acted on by the air current, we can by evaporation of a quantity reduce the temperature, and that is what takes place in a cooling tower, which is an apparatus designed to distribute the water so as to expose a large surface to be acted on by the air. Now, for every pound of water evaporated there is a reduction of temperature which will allow of a pound of steam being condensed, and just bring the remainder to the original temperature. It will be plain, therefore, that in operating a cooling tower there can be no more water used than when running non-condensing. In fact, there is not as much, because there is not as much water evaporated in the tower as there is condensed, as the surface of the tower and pipes have a cooling effect; also, the direct rise in temperature of the air takes away a quantity of heat without evaporating any water.

The engine will require less steam, consequently there is a smaller quantity of feed-water used than when running non-condensing. The system, therefore, allows a plant which has to buy even its feed-water, to run condensing at a less expense for water than when running non-condensing. The details of the system are, at the start, like an ordinary condensing plant. The steam leaves the engine, passing through the condenser, is here condensed by water taken from a small reservoir instead of some natural supply. The water passes to the air pump and is pumped out, forming a vacuum as in an ordinary condensing plant; but now, instead of letting it run to waste, it is elevated to the top of a tower, either by the air pump itself, if the tower is low, or by an auxiliary pump should the tower be high. This is preferable in any case. The water is distributed over the surface of the filling of the tower, falling to the bottom through the up-coming current of air, and the temperature is thereby reduced sufficiently to be discharged into the small reservoir from which the condenser takes its water, and is used over and over again. The details of the tower are:—At the top of the tower is an arrangement to distribute the water over the whole surface of the interior. This distributor has taken many forms, some of which are quite ingenious. Some of the latest are the revolving distributor, illustrated in "Power," for March, and other mechanical papers. This distributor is mounted in the centre of the tank on ball bearings, and the water issues from the cross pipes like the ordinary lawn sprinkler, and distributes the water evenly. Another distributor which is used in towers with what might be termed partition filling, is made with a little trough across the top of each partition, with main channels feeding them. The top of the small troughs are made like a saw on their top edges, and the fine streams of water run through the hollow of the teeth and spread over the surface of the partitions, making a very even distribution. There are numerous other forms, such as perforated plates, screens, etc., all of which will work, but do not distribute as well as the two mentioned. The filling of the tower or material over which the water is distributed, has taken even more forms than the distributor. From the time when brush was used to the present and latest wire filling, the same idea was at the bottom of every change, namely, to make a given size tower do more work. The cooling effect in a given size tower is a very important point in metropolitan plants, where room is valuable. The first filling was brush. Then round poles were tried. About the same time and at different times since pans have been tried with some success, but was never equal to the tower system. The next was a partition tower, or a board filling. This has taken a great many shapes, the boards being arranged to break up the water and air currents in every conceivable manner. Sheet iron has been tried in various forms, some like stove pipes and others arranged in sheets. The latest and best filling is tile and wire netting.

The tile tower has been described in Power and other mechanical papers. It is very satisfactory. One point against this filling for a large tower is its great weight. The wire or Barnard tower is filled with wire netting rolled up loosely and set up on end. In these towers a settling chamber is provided at the bottom, and a heavy grating is placed across some distance above the water. In this space the fan discharges its air. On top of the grating is placed the tile or wire, whichever filling is used, and it is continued on up as far as it is able to



BARNARD'S PATENT WATER COOLING APPARATUS,
AS ARRANGED ON ROOF OF A BUILDING.

support itself, breaking joints, so as to break up the streams of water. There is a portion of the tower carried on up above the filling, to allow the particles of water to settle out of the air current. This prevents a spray flying from the top of the tower, and also any of the water being wasted. Information on the formula for calculating the size of towers is not very extensively known. As far as can be learned, about 50 square feet of cooling surface is required per h.p., when a large quantity of air is used, say 100 cubic feet of air per h.p., and varies with the amount of air and with the arrangement of the filling. In making up estimates the term h.p. does not give definite information, because the amount of steam used per h.p. varies from 15 to 45 lbs. per h.p. per hour, according to the size and type of engine. The only way is to get the water consumption of the engine and figure from that, the same as for running condensing. When an engine is using, say 25 lbs. of water per h.p. per hour, it will require about 4·8 cubic feet of tower for each h.p., with sufficient air and wire filling. With tile filling the cubic capacity required is about 6·5 cubic feet per h.p.

Cooling towers are becoming numerous. We have one in Canada, at Montreal. Two have lately been started at Detroit, and reported as giving excellent satisfaction. The accompanying illustration of Geo. A. Barnard's towers arranged for surface condenser, with the tower on the roof of a high building, will illustrate one application of the system. Further illustrations are not exhibited, because several of the mechanical papers have lately fully shown the different applications of it. It is estimated that the cost of operating a cooling plant is from 2½ to 5% of the power of the engine, which leaves a large net balance in favor of the apparatus, fully justifying its application on plants of any magnitude, or where the cost of coal exceeds $1.00 per ton. If a tower is placed on the roof a surface condenser should be used, and the ascending column of warm water is balanced by the descending column of cool water, and the actual head the pump works against is the height of the tower. If the tower can be placed in the yard, a jet condenser may be used, unless the object is to get pure water for the boilers. In the beginning of this paper the cost of adding a condenser to a 100 h.p. plant was shown to effect a net saving of $420, or 20%, nearly. The cost of adding a tower to such a plant should not exceed $700, the interest on which at 6% is $42, leaving a net saving of $378. This would make a very good showing on such a small plant, and would in most cases be much larger. Another point is, in cases where engines are carrying a full load and a little more power is required, attaching a condenser would increase the power about 20%, thereby avoiding buying a new engine, the plant carrying this extra load at the same expense for coal and water.

SOME CENTRAL STATION ECONOMIES.

By P. G. Gossler.

On the occasion of an electrical convention a statement of results obtained in the reconstruction of light and power plants will, no doubt, be acceptable, particularly so to station managers *who may be confronted with the fact that their plant is not modern*, and probably not a paying one, and that the time has arrived when reconstruction is no longer a choice but a necessity.

It is well known that many central stations which have not been operating on a paying basis have been turned into profitable investments by prompt measures having been taken to modernize them, and to put them on a footing to meet competition either from companies already in the field or contemplating entering it. To do this, it has generally been necessary to reconstruct the entire electrical part of the plant from the generators to the lines and transformers, replacing the old generators and transformers by the more efficient apparatus now manufactured; rebuilding and re-designing the switch-board, and last, but certainly not least, the re-arrangement of the feeders and mains, to give economical distribution, to overcome the inductive effects, and to bring the feeder losses within the limits of good practice.

Those who have been so unfortunate as to be in charge of a plant operating generators of small capacity, with a regulation anywhere from 30 to 40 %, with drops in the feeders of the circuits varying from 1 to 10 %, with no feeder regulators, with the wires so arranged that the worst possible inductive pumping effect is obtained, with a type of transformer whose leakage current is several times what modern practice permits, with a regulation corresponding in percentage to the drops in the feeders, and combined with all this a decided variation in the house wiring drop, will appreciate what a restful feeling is realized, even in the contemplation of a reconstruction that will include new generators and transformers of high efficiency and close regulation, and a safe switch-board. Those who are aware that their service is not what it should be, and who have analyzed the situation, know that the only remedy for the trouble, the only guarantee for a service that will be acceptable to the public and one that can successfully meet competition, is the replacement of any old and inefficient apparatus in use by that which is modern and efficient. This may mean a large outlay, but it should be done at any cost. It may mean the scrapping of old dynamos and transformer—they are of no use to anyone now—what is wanted is only a first-class apparatus. Experience has shown that the first cost of apparatus cannot receive the consideration that it did a few years ago; if it does there will be within a comparatively short time the same problems to solve.

The following gives results obtained from the partial reconstruction of one plant. It does not give a full idea of what will be accomplished by complete reconstruction inasmuch as that part so far carried out has been confined to transformer and line changes.

The reconstruction planned for the present and now in progress, will affect only the alternating system of a plant which also furnishes direct current arc and motor service. These changes will include the replacing of the present single phase generators and line shafting operating them by two phase generators with an inherent regulation of 4 to 5 % without compounding devices, the generators to be belted directly to the engines: the building of the new switch-board for two phase currents serving light and power from the same circuit at 2000 volts: rearranging the lines for two phase distribution; and reducing the station load and bettering the service in general by replacing all of the old transformers on the lines by the best transformers obtainable.

To proceed with a systematic reconstruction, the first things necessary are reliable records, at least of what the plant and lines to be reconstructed consist. For the plant herein referred to it was necessary to establish pole line and circuit maps as well as transformer maps. It may be said that such a system of records in detail and kept up to date is necessary for the economical operating of an electrical lighting station.

For the pole line records a card catalogue was arranged, each card having a number corresponding to a pole; in connection with this card catalogue there is a map on which each pole is located with its number; also, for further convenience in making out reports and locating poles, each pole itself was numbered.

The following cut represents a form of pole card which was found to answer the purpose very well.

On the card representing a particular pole all of the wires are shown in their relative positions on the pole by numbers placed over the pins to which the wires are attached, the numbers indicating the circuits of which the wires form a part. By means of this card the positions of the wires forming the different circuits were clearly shown, also what changes in the relative positions of the wires were necessary to overcome existing inductive effects, the latter being a source of much annoyance. In fact, the pumping on the circuits due to mutual induction, prior to their rearrangement, when circuits supported on the same pole were running from dynamos on different engines, was so serious and caused so much fluctuation of the lights that it was necessary to rearrange the relative positions of the feeders of all the circuits to counteract these inductive effects. Very satisfactory results were obtained when the rearrangement of the wires had been carried out. Prior to this change, to overcome fluctuation, it was necessary to feed all circuits on the same pole line from one set of dynamos operated by one engine, which was very often not convenient and only possible with a large loss in operating expenses. If all the circuits on the same pole line were not run from the same set of dynamos, the service was such as to make life a burden for those who were responsible for it. After the rearrangement of the feeders to overcome the pumping, it was possible to run the circuits entirely independent of each other and in a manner most convenient and economical for operating, which is, of course, a source of much economy as well as satisfaction.

In connection with this pole catalogue, circuit maps were arranged, which consisted of diagrams for each circuit, showing the streets upon which the circuit ran, and the size and length of each section of wire or wires.

At the same time these records were being made out, transformer charts were prepared, which consisted of maps for different sections of the city covered by the different circuits. On these maps each transformer was located by a small square stamped on the map, and within this square was written the name of the customer being served from this transformer, the number of lamps installed, the revenue per year, the revenue per lamp per year, the estimated number of hours burned per lamp per day, and the probable number of lamps burning at any one time. There is also indicated on these charts the size and length of secondary wires from the transformer to the customer's cutout. All this information was found necessary for the proper "bunching" of customers on the transformers and for the loading of the transformer.

Wherever possible, secondary systems were established, to which several transformers were connected in parallel, in which case the size of the secondary mains between the transformers was such that the drop in these mains was small compared to the drop in the transformers themselves; in this way the transformers were made to share, more or less, the load equally between them. When a secondary system of distribution was not economical, single transformers were located. In determining whether a customer was to be included in a bunch of customers, all of whom were to be fed from one transformer, or whether it was more economical to place a separate transformer, it was necessary to make an approximate estimate of the cost of locating the transformer for each case. When the interest on the cost of placing a separate transformer plus the cost of maintenance of the transformer, was more than the interest on the cost of connecting a customer to a transformer, feeding other customers, the connection in question was made to the transformer feeding the "bunch." However, even if the difference in annual cost was small in favor of a separate transformer, connection was made to the "bunch." In making these calculations a fixed drop in the secondary mains was allowed, and the load, i.e., the probable number of lamps burning at any one time, for calculating this drop, was determined from the records on the transformer charts; of course the character of the service goes a great way in making this last determination. A separate transformer was placed only when the total annual cost for the placing and maintenance of such transformer did not exceed the sum of the two following costs—the interest on the cost of placing and maintenance of wire necessary to connect the customer to the nearest "bunch' transformer, and the increased cost due to necessary increase in size of transformer. The annual cost of a transformer on the lines was considered to include the cost of the iron losses, figured as costing the electrical lighting station at an assumed rate of one-tenth (.1 cents) per lamp hour of 55 watts, a 5% interest on the cost of the transformer, and the high rate of charge of 10 % depreciation. To facilitate the bunching and ioading of transformers in conjunction with other data, the following table :

Capacity in lamps.	Cost of transformers	Int. on cost at 5%.	Depreciation 10%.	Leakage.		Cost of leakage at 1 per lamp hour, 55 watts.	T'l. ann. cost of transformers on lines 24 hrs. ser
				Watts	Watt hours per year.		
10	18.00	90	1.80	29	254000	4 62	7 32
15	22 00	1 10	2.20	30	262100	4 78	8 08
20	26 00	1.30	2 60	32	280000	5 10	9 00
30	32 00	1.60	3.20	35	306400	5.48	10 38
40	39 00	1.95	3 90	37	324000	5.88	11.73
50	47 00	2.35	4 70	51	446000	8.10	15 15
75	68.00	3 40	6 80	65	569000	10 33	20 53
100	80 00	4 00	8.00	77	674500	12.25	24 25
150	112.50	5.64	11 25	85	744000	13 50	30 38
200	150 00	7 50	15 00	125	1093000	19 90	42 40
300	225 00	11 25	22 50	150	1312000	23 85	57 60
400	300 00	15 00	30 00	160	1400000	25 00	70 00
500	375.00	18 75	37 50	170	1488000	27 05	83 30

The principal factor in determining the size of a transformer is the character of the service, a more liberal allowance being made for an overload in a residence than could be made in a commercial district. A good transformer should stand an overload for several hours of at least 25%, and for a shorter period of 50%, or even more.

What has been stated above in regard to the placing and determining the size of transformers assumes of one make of transformers being considered. The subject of selecting a type or make of transformer has been freely discussed elsewhere. It has been shown conclusively from the experience of electric lighting stations everywhere that first cost is no longer the principal factor to be considered in determining what transformer should be chosen to allow of economical operating of a lighting station. Obtain a guaranteed transformer leakage from various manufacturers, substitute these guaranteed leakages for the different sizes of transformers in a table, similar to the one given above, and a comparative statement of the annual cost of different makes of transformers can readily be made from which the most economical type of transformer for the local conditions can be determined. In connection with the above, transformer construction, regulation and efficiency should be considered. It is generally a fact that transformers of small leakage currents have the highest "all day efficiency." With the guaranteed leakage currents there should also be a guaranteed regulation not exceeding 2½ or 3%, which is obtainable, for the smaller sizes. The mechanical construction of the transformer is as important as either its efficiency or regulation ; the safety of the customers' premises depending upon the protection of the secondary coil from coming in contact with the primary coil, it is necessary that the method of insulating the coils from each other be reliable and absolutely safe. There can be no question that it pays to replace inefficient by efficient transformers. There is but one course to follow if the station be loaded with unnecessary transformer leakage, and that is to replace, at the earliest possible moment, the old transformers by new transformers, using secondary systems where economical, and by this replacement cut down operating expenses and increase the station capacity.

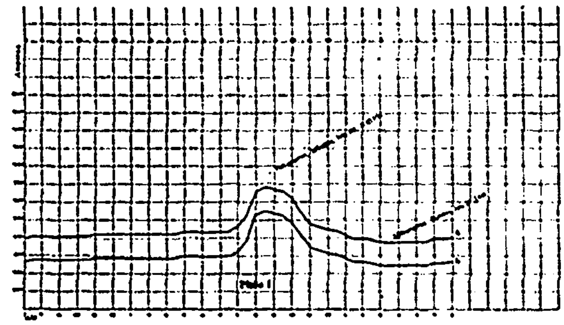
At the beginning of the reconstruction herein referred to there were 1,160 transformers on the lines with approximately 53,000 lamps wired. At the time the following results were collated, there had been 473 old transformers removed from the lines, while 229 new transformers had been put up, leaving a total of 916 transformers on the lines serving about 60,000 lamps. Of these 229 new transformers, 187 had replaced 345 old transformers, while 42 had been used for new customers. Of the 128 old transformers yet to be accounted for, 18 had been removed on account of discontinuation of service, and 110 had been taken from the lines on account of being able to connect the customers served from them to old transformers already erected in their immediate vicinity. This "bunching" of customers on to old transformers was made because new transformers could not be obtained at the time and it was necessary to reduce the leakage load before winter.

The lightest load registered during the year preceding the commencement of the reconstruction was 380 amperes. Ten months later, with about 8,000 more lamps wired on the service than at the time of the 380 ampere load, above referred to, the lowest load recorded was 245 amperes, or a decrease in the load line of 135 amperes, this decrease in leakage load being due to the transformer changes just mentioned. The leakage of the 229 new transformers was 19 amperes, which means that the 473 old transformers had a leakage of 154 amperes, or an average leakage of .325 amperes per transformer removed, which figure has been verified by leakage tests made on the old transformers which have been removed from the lines. Thirty six of the 135 amperes reduction was due to the removal of the 110 old transformers, and placing the customers served *from these on other old transformers*, making secondary distribution systems. From this is deduced the fact that by replacing the 345 old by 187 new transformers, a saving was effected of 99 amperes. The average saving for the 187 changed is then .529 amperes per change, which with coal at $2.75 per ton, means an annual saving of $25.58 per change in coal alone. The average cost of the 187 changes, including the cost of new transformers, all extensions of wiring for secondary mains and all labor, crediting these orders with old transformers as scrap only, was approximately $65.00. As stated above an annual saving per change in cost of coal would be effected of $25.58, therefore at this rate the new transformers will pay for themselves, if the saving in coal only is considered, *in about two and a half years.*

When the 1,160 transformers above referred to have been replaced by new transformers, and the bunching of customers has been carried out, it is estimated there will be but 636 transformers required, and the total leakage will be less than 75 amperes.

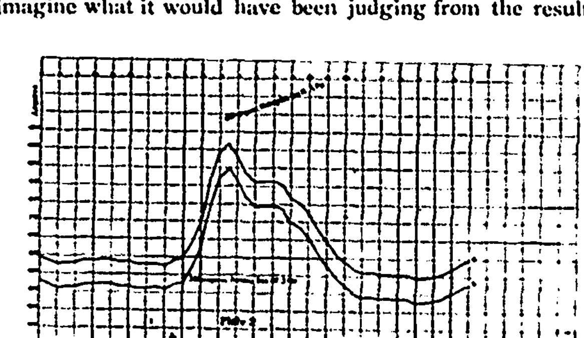
The following curves show three (3) actual station loads; an average load for eight months from June 1st until February 1st, and for the July and December of these eight months, also the estimated loads for the same periods had the *reduction in transformer leakage so far actually obtained been* accomplished.

Plate 1, Curve A, represents the average load on the



station during the twenty-four hours for seven days, beginning July 19th and ending July 25th, the highest point reached being 760 amperes, and the lowest 380 amperes.

Curve B represents the average load that would have been on the station for the same period had the 917 transformers been on the lines instead of the 1,160, and the saving of 135 amperes been accomplished. As this *paper is only dealing* with actual results obtained, the curve showing the estimated load on the station for the same period, had this reconstruction been complete, will not be plotted, but it is not hard to imagine what it would have been judging from the results,



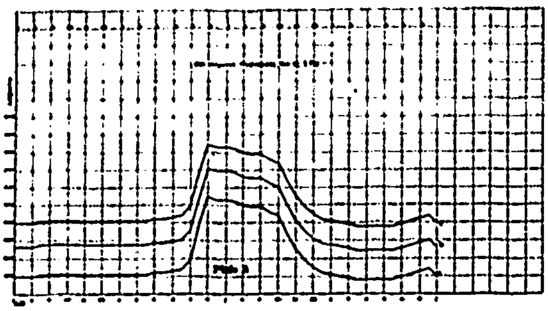
so far obtained, with the transformer changes barely one-third finished.

Plate 2, Curve A, represents the average station load during the twenty-four hours for the seven days, beginning

December 18th and ending December 24th, the highest point reached being 1280 amperes, and the lowest 380, this being the heaviest week of the year.

Curve B represents the estimated station load for the same period, had there been the 917 transformers instead of the 1,160 on the lines. While the third curve showing this estimated load had the transformer changes been complete, has not been plotted, yet it is safe to assume there would have been a difference in the maximum load reached of 300 amperes, so that it would have been necessary to provide station capacity for a maximum load of 980 primary ampere instead of 1280 primary amperes.

Plate 3, Curve A, represents the average primary ampere,



load on the station for the eight months from June 1st to February 1st.

Curve B represents the estimated load during the same period had the reduction in load so far obtained—135 amperes—been accomplished.

Curve C represents the estimated load during the same period, assuming a reduction in primary leakage of 300 amperes.

This reduction in station load with an increased number of lamps wired, due to the decrease of transformer leakage, can be regarded, first, as a saving in coal and operating expenses in general and, secondly, as either an increase in station capacity already installed, which means an increase in the earning capacity of the plant, or a decrease in capacity necessary to be installed to handle the output at time of maximum load.

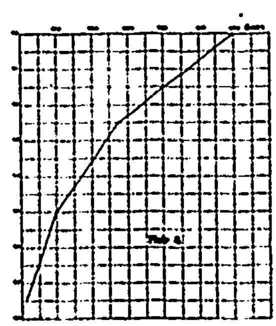
A decrease in transformer leakage of 135 amperes means a decrease in load of 135 amperes for every hour of operation, which represents a saving in coal, at $2.75 per ton, of about $7,348.00 per year, that is for a station running twenty-four hours per day. Apart from this increase in capacity, there is also the saving due to running a smaller engine for the day load, and the consequent saving in labor, oil, etc.

A decrease of 135 amperes leakage means an increase in earning capacity of the station of approximately 270016 CP lamps burning, or about 9,000 lights wired. As so much of the advantage to be gained by this decrease in transformer leakage depends upon the kind of transformer used, it would only seem safe and wise to insist on all transformers *coming within guaranteed limits for leakage and regulation.* The only way to know that transformers come within the prescribed limits is to get them from manufacturers who are known to build the very best transformer, or better still, test each transformer as it is received from the factory. Inasmuch as transformers made by different manufacturers, and apparently alike in every respect and seemingly identical in construction, are known to vary from twenty-five per cent. to a hundred per cent. from each other, the advisable plan appears to be to test each transformer as it is received. This plan of testing transformers is followed out in many stations and is the only sure means of keeping the leakage within the calculated limits.

The reduction in leakage load so far obtained in the reconstruction under consideration has not been accompanied by any sacrifice of transformer regulation. The type of new transformer used is one giving the best all round results, that is, one in which regulation and leakage are so proportioned in its construction as not to benefit one at the expense of the other. In thickly populated or central business portions of the city, where an extensive secondary distribution is possible, and where large transformers may be connected in parallel at different points, it would be an advantage to use transformers of very small leakage current and high "all day efficiency," as in this case the transformers share the load between them, and regulation can be sacrificed to gain diminished leakage current. However, as it is only in very large cities, and only in the most thickly populated centres of these that the secondary distribution system can be economically used, the make of transformer giving the best all round results should, in general, be selected. To further improve the regulation beyond that to be obtained by improved transformer regulation it is intended to change the primary distribution from 1000 to 2000 volts, thereby decreasing the copper losses on the existing circuits to one quarter of the present losses, and reducing the feeder drops so that good service and regulation will be obtained without the use of feeder regulators or the erection of additional copper. A source of additional improvement in regulation will be the use of generators with very close regulation. The necessity of transferring the circuits from one dynamo to another makes close inherent regulation in generators an imperative feature if satisfactory service be desired. Transformers with good regulation, feeders having small drops, and generators of close regulation, mean that the ordinary changes of load and transfers of circuits from one generator to another can be made without materially affecting the voltage on the lamps in service. The generators selected for the reconstruction herein spoken of to replace the present single phase generators are of the two phase type and are of such construction mechanically and electrically as to make practically impossible the hairbreadth escapes and the sleepless nights familiar to many operating old style apparatus. The sense of security which takes possession of one after becoming familiar with the type of machine selected can only be appreciated after actual experience in operating. When the reconstruction under consideration has been completed there will have been installed five 300 KW generators, two on one engine, two on a second engine, and one on a third engine. The two generators running from the same engine will be run in parallel when the load requires it, making the units on two of the engines 600 KW, with the advantage of having a more flexible system and a possible saving due to running a 300 KW when a 600 KW would be but partially loaded. The construction and location of the engines was such as to make it impracticable to put 600 KW generators on the two large engines, had it been so desired.

Probably the most economical and certainly the most convenient unit of power for operation is one that has the capacity to carry the day load, the remainder of the dynamos being of a uniform type and size. In the case in question the day load, if the service be confined to lighting would, as stated above, be less than 100 KW, but the adoption of the two phase system will permit of the increase of the day load by the sale of current for motor service, to at least the capacity of the small engine. The small engine, to which is connected the single 300 KW generator, will be run while the day load remains within the limit of capacity of this engine and generator. Should this engine or generator require repairs and it be neccessary to run one of the large engines during the day, only one of the 300 KW generators need be excited to carry the day load, introducing a saving not possible if a 600 KW had been placed on this engine, thus giving a higher "all day efficiency" for the two 300 KW generators than could be obtained from one 600 KW generator. The 300 KW units, run either singly or in parallel, are sufficiently large to allow of any desirable arrangement of circuits of ordinary size.

Another factor in increasing the capacity and earning power of a plant is the use of an efficient lamp with an economic



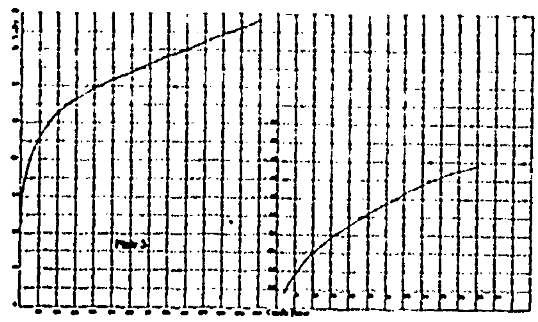
life. The best known makes of lamps on the market have a difference in efficiency of from ten per cent. to fifteen per cent., which means a difference of from ten to fifteen per cent. in the earning power of the plant, depending on the efficiency of the lamp in use. A ten per cent. difference in output or capacity should receive consideration.

Lamps with long life are found to be inefficient; very efficient lamps are usually short lived. There is a point between these extremes which makes a lamp suitable for electric lighting station use. Using an efficient lamp increases the earning capacity of a plant and permits of using higher candle power lamps with a proportionally less increase in cost. An increase in candle power either by high candle power incandescent lamps of high efficiency or small incandescent arc lamps seems to be the best way to meet competition from gas either with the ordinary or the "Auer" burner.

It has been advocated by some, to meet this demand for more light, to running the lamps at a voltage above that for which they are rated, thereby running the lamps at a high efficiency. An examination of the following two Plates, 4 and 5, will show the fallacy of such a makeshift.

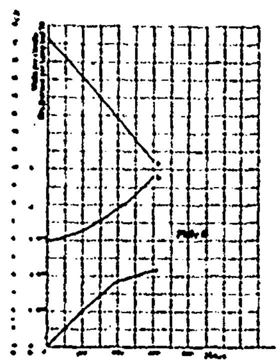
The curve on Plate 4 is the result of many lamp tests, and shows the variation in lamp life for lamps of the same grade when run at different voltages.

Plate 5 shows a curve for the same make of lamp of the



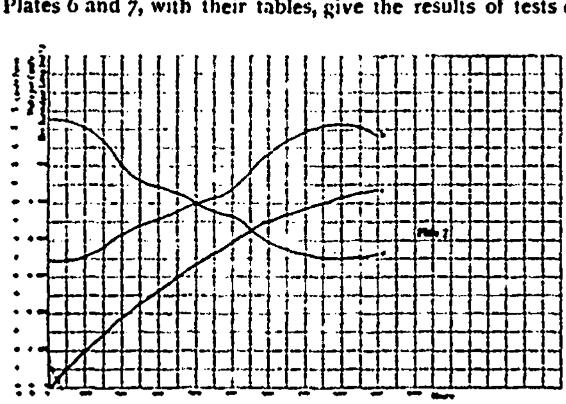
same efficiency, giving the candle power of a lamp at various voltages. As 600 hours is probably the average life of the lamps now on the market, the effect of running this grade of lamp which was rated as a 600 hour lamp, above its rated voltage may be regarded as the effect on the average lamp now offered to the public.

From these curves it will be seen that running a 50 volt lamp at 52 volts, or increasing the voltage four per cent. increases the the candle power about nineteen per cent., while the life of the lamp is decreased about forty-three per cent. Running the lamps at a pressure of 55 volts, or a ten per cent. increase of voltage increases the candle power of the lamp about sixty-six per cent., while the life of the lamp is decreased about eighty-three per cent., from which it would seem that to a plant supplying current to a large number of incandescent lamps and furnishing renewals, running them above the rated voltage means a large increase in the lamp renewal account, both for material and labor. Run the lamps as near their rated voltage as possible, and the lamp renewal account will be a minimum. Good regulation on the circuits goes a long way towards keeping this account down. A daily rise in voltage from three to



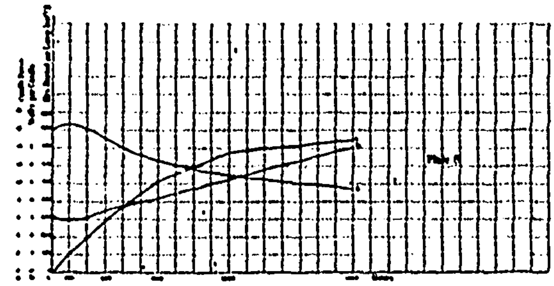
four per cent. above normal for a short time will reduce the life of a lamp of good economy about one half.

Plates 6 and 7, with their tables, give the results of tests on

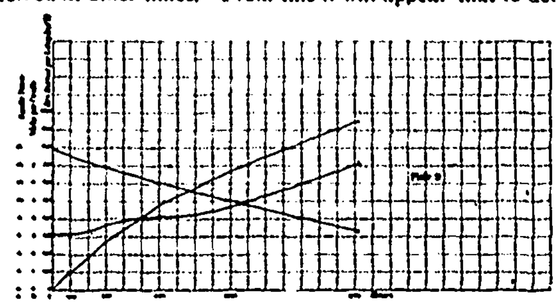


two very well known makes of lamps, when the lamps are run at a voltage ten per cent. higher than their rated voltage.

Curves 8 and 9, with their accompanying tables, give the results of life tests on the same makes of lamps when running at their rated voltages. Plates 6 and 8 are for the same make of lamp. Plates 7 and 9 are for the same make of lamp, but of a different make from the lamp, the curves for which are given on Plates 6 and 8. The results of these tests are of especial value to electric lighting stations from the fact that throughout the test the conditions under which the lamps were run were made to conform to the conditions imposed upon lamps in commercial service. It has been determined that lamps which have been made by identically the same process differ in lots. It has been



observed that lamps received from the same factory do not average the same candle power and efficiency for different invoices, that is, lamps received in one invoice are generally quite uniform throughout that lot, but they vary considerably from lamps received at other times. From this it will appear that to derive



full benefit from using efficient lamps it is necessary to test the lamps and ascertain that they come within the limits of efficiency which have been decided to be the most economical for the local conditions. To determine what lamp is best suited for any electric lighting station, it is necessary to know the cost of producing current per lamp hour, and having established this for any special make of lamp, the following formula will permit of a comparison of different makes of lamps and the determination of the best lamp for the conditions under which they are to run. In considering the cost of production per lamp hour in connection with the lamp question, the cost of service may be divided into three parts:

A. That portion of the service per lamp hour that is practically not affected by the average efficiency and life of the lamps and such portion of the maintenance, operating and general expenses, as is practically not increased by increasing the current consumption per lamp hour.

B. The cost per lamp hour, coal, water, interest and depreciation on the lines, dynamos, engines, etc., and such part of the expense of the service as increases proportionately to the amount of current served per lamp hour and as the maximum station output.

C. The cost of the lamp per lamp hour, and the expenses per lamp hour for replacing exhausted lamps. This is equal to the cost of one lamp, plus the cost of exchanging one exhausted lamp, divided by the average life of the lamp.

Under the first division (A) should be included the cost of fuses, meters, transformers erected, and secondary connections, line construction, maintenance, etc., and such proportion of the operating and general expenses as is not increased by increasing the current consumption per lamp hour.

Under (B) should be included that portion of the cost of service per lamp hour exclusive of lamp renewals that increases proportionately to the current consumed per lamp hour.

These divisions of cost should be so made that the sum of A, B and C, will represent the total cost of service per lamp hour, the values of A, B and C representing the above divisions of cost having once been established for a lamp of any given efficiency and average life for any particular lighting station, the cost of service per lamp hour for this same station with any other lamp which has a current consumption different from the current consumption of the first lamp, and having an average life of "Y" hours, would be $A + XB + C' =$ the cost of service per lamp hour, "X" representing the proportion between the current consumption of the lamps being compared, and "C'" being the cost of one of the new lamps, plus the cost of replacing one exhausted lamp, divided by "Y," the average hours of life of the new lamp.

This formula applies for comparing the cost of producing light with lamps having different costs, efficiency, and average lamp life, when they are to be burned in the same plant and under the same conditions of average lamp hours burned per lamp installed, and the same maximum number of lamps burning for a given number of lamps wired. Value (B) in this formula includes the coal consumption and the materials which practically vary proportionately to the watt hours output required for providing the light. It also includes the interest and depreciation on the plant which must be enlarged when the lamps consume large amounts of current, because the generating and supplying capacity of the plant must be proportionate to the maximum output called for by the lamps. In many plants the interest and depreciation account will form quite a considerable portion of the factor B, and as a large value to the factor "B" makes a showing against the high consumption of current per candle power hour very bad, it would appear that any lamps installed that did not burn at the time of maximum current output from the station could be economically used of a poorer efficiency with longer life than lamps which do burn at time of maximum output, because any additional demand for current on a plant that is not a call for current at the time of maximum output, does not require an increase of plant capacity. In estimating the best efficiency per candle power hour, or per lamp hour, for these lamps that do not burn at the time of maximum output, the cost of interest and depreciation entering into the factor "B" in the formula *(in fact all the costs that increase proportionately as the size of the plant required to serve the lights wired)* should be excluded from the factor "B." The result is that lamps that do not burn at the time of maximum output can be econominally used of considerably lower efficiency than lamps that do burn at that time.

The outline of the reconstruction contained in this paper and the statement of the results so far obtained are for an electric lighting station serving 60,000 incandescent lamps. Another much smaller electric lighting station has had its transformer system *rearranged, within the past year, upon the same plans* outlined for the station serving 60,000 lamps. This smaller station had, and still has, a capacity of two 500 light dynamos, serving 2,100 lights wired. At the time of heavy load, the station was loaded beyond a safe limit. Apart from this the demand for an increase in the number of lights wired could not be met. An increase in the boiler, engine and dynamo capacity appeared, to some, the only way to meet the requirements; however, this was unnecessary as the transformer system was rearranged, and thereby ample capacity to meet the immediate demands was furnished. Prior to this rearrangement there were 79 transformers on the lines, having a leakage of about twenty amperes. The 79 old were replaced by 42 modern transformers, having a leakage of less than four amperes. By this rearrangement and the substitution of modern for the old transformers, a reduction in load was obtained of sixteen amperes which permits of the station not only carrying safely, with the same station equipment, what was formerly an overload, but also permits of an increase in the earning power of the plant of approximately one thousand 16 candle power lamps.

TABLE C.

Hours Burned.	No. of Lamps Broken	Average Current per Lamp	Average Candle Power per Lamp	Per Cent of Candle Power	Watts per Candle	Total Lamp Hrs. Burned	Lamp Hrs. Burned per Lamp Installed.	Average Voltage on Lamps.
0	0	1.04	16.1	100	3.21	0		
100	0	.99	16.6	103.	2.95	2000	100	50.94
300	3	1.045	15	93.2	3.40	5767	288.4	51.3
600	6	1.05	12.6	78.3	4.17	10374	518.7	52.2
1000	16	1.14	11	68.4	5.18	13331.8	666.6	52
1700	18	1.31	9.5	59.1	7.05	14843 8	742.2	5 8

TABLE D.

0	0	1.03	17.3	100.	2.97	0		
100	0	1.00	15.18	88.	3.3	1000	100	56 4
200	3	1.00	12.8	74	3 9	1838	183 8	56 2
300	8	1.00	10 4	60.2	4 8	2157	215 7	55 ?

TABLE J.

0	0	1.01	15.9	100	3.16	0		
100	1	.96	15.2	95 6	3 5	1954.5	97.8	50.94
300	4	1 013	13.9	87.5	3.65	5369 5	268.5	51.3
600	8	1.02	12.2	77.	4.18	9583.5	479.2	52.4
1000	12	.96	10 1	63.6	4.75	13382.7	669.1	52.
1700	14	.97	6 8	42.8	7 13	18090.5	904.6	51.8

TABLE K.

0	0	1.00	14 5	100	3.16	0		
100	0	1 00	14 04	97.	3.56	1000	100	56.4
200	2	1 00	12	83.	4.13	1896	189.6	56.2
300	3	1.00	10 9	75.2	4.58	2630	263.	55.2
400	3	1 00	9 97	68.8	5.01	3330.	333.	55
500	4	1 0	9.3	64.2	5.37	3954.	395.4	56.
600	5	1.00	7.9	54.5	6.33	4525.	452.5	56
800	8	1 00	7.	48.3	7.14	5157.	515.7	56.2
900	8	1 00	7.3	50.4	6.85	5357.	535.7	56.5

Location No.............................. St.......................Ave.

And Opp .... St. ......Ave N.E. S.W. Corner.

Height of Pole ....

Kind of Pole .... For Line City Lamp.

Condition of Pole ....

1st Arm Pins Wires

2nd " " "

3rd " " "

4th " " "

5th " " "

6th " .... " .. "

7th " " "

8th " " "

9th " " "

10th " " .. "

Transformers ....

Arc Lamps .. .65 c.p. .. 32 c p ...

Lightning Arresters ....

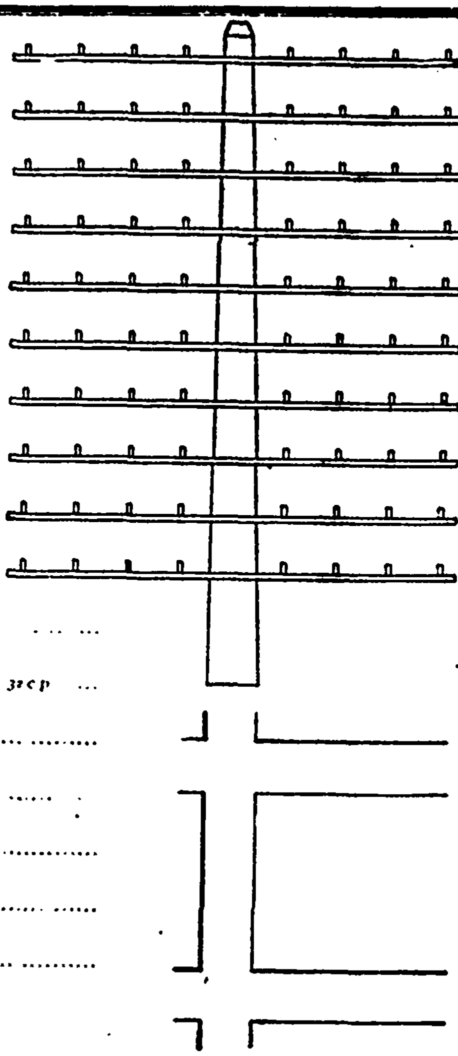
Remarks ....

....

....

Located by ....

.189



THE OUTLOOK FOR THE ELECTRIC RAILWAY.

By F. C. Armstrong.

It is a significant evidence of the confident spirit with which we have learned to regard the sure and rapid progress of modern electrical invention that we accept to-day without comment and as an established practice what was but yesterday a matter of tentative and doubtful experiment. This rapidity of achievement has characterized the development of the electric railway, in common with the other great departments of electrical industry, and has already been productive of results of which we can scarcely as yet appreciate the economic and social importance.

Up to within the past year, however, the application of electric motive power for railway purposes has been practically limited to the improvement, amounting to a revolution, of the street railway proper, and an extension of its field as the suburban railway. The work in this direction, though difficult in detail, is necessarily limited in range, and at the present moment may be said to have reached a stage approaching finality. The street railway motor of to-day may be considered, in view of the conditions under which it operates—limited space, exposed position, light weight and severe service, as a highly efficient and satisfactory machine. The controlling apparatus has been developed to an equally high degree of perfection, ensuring in the best types a maximum economy of current, and reduction of strain on the motors under varying conditions of operation, and even adding to its normal function the duties of an electric brake. In the power house, the substitution for *the small belt-driven generator, of the large, compact, slow-speed direct-*connected unit, with its steel frame and iron-clad armature, leaves little room for improvement in the way of higher efficiency, closer regulation or greater durability. Improvements in design and material have done much to remedy the unsightliness and unreliability of the devices used in overhead construction and the standard pressure of 500 to 600 volts is found, even for suburban extensions of considerable length, to be commensurate with a reasonable copper economy. From a financial point of view the position of the electric street railway is equally assured and satisfactory. No field for legitimate investment is now more favorably considered than that offered by the securities of a well-managed and *well-equipped electric railway in a city or town of any size suitable to* its capitalization. As evidence of the financial importance to which the electric street railway interests in Canada have attained, may be cited the fact that there are at present in operation, or being constructed in the Dominion, 36 electric street railways, having a total mileage of close upon 600 miles, using 750 motor cars, with a total generating capacity of 19,500 kilowatts, and representing an actual investment in round figures of over twenty millions of dollars.

At this point, and at a meeting held in the city of Toronto, it is peculiarly fitting by way of contrast and as epitomizing the development of less than one decade, to quote from a catalogue issued nine years ago, in 1887, bearing the title "The Van Depoele System of Electric Railways," in which under the heading "Facts about running the Toronto Electric Railway in 1885," we find the following:

"Plant consisted of one engine, automatic, 10 x 16 cylinder, 150 revolutions per minute; one electric generator, forty horse-power; one electric motor, thirty five horse-power; one motor car, weight six tons; three passenger cars, each two tons. Average number of passengers carried, eighty-three per car; estimated weight of passengers per train, 16 tons; total weight of train, 11 tons; length of track, one mile (with one grade of six per cent.); average speed, 30 miles per hour; passengers carried in 5 days, 50,000; average consumption of coal per day of ten hours, 1200 lbs.; distance travelled in ten hours, including stopping to take on passengers, 200 miles."

The generator in the case, it may be added, was a 40-light arc machine, having, it is stated, "an electromotive force of 1300 volts, and an intensity of current of about 18 amperes," and the single motor, belted to the axle, was a 35-light machine of similar type. In the same catalogue we find a description of each of the Van Depoele roads in operation at the date of its issue. The list is a short one—Montgomery, Alabama, 1½ miles; Detroit, Mich., 1¾ miles; Windsor, Ont., 2 miles; Appleton, Wisconsin, 4½ miles; Port Huron, Michigan, 3 miles, and Scranton, Pennsylvania, 2 miles; a total of 14¾ miles. It is amusing to note following this modest list of roads installed, the bold challenge that "As the matter now stands we have more miles of electric railway now in successful operation than all the other electric railways in the world combined."

Coming now to a consideration of the subject of this paper, it is not unreasonable to augur from the success of the electric railway in the past, an outlook for the future equally brilliant and promising. We may leave out of consideration the work which still remains to be done in affording rapid transit for the cities and towns which are as yet either working without street railways altogether, or in which the existing systems are still operated as horse or cable roads. The horse as a propulsive agent for the street car, is steadily pursuing his course to his destined place in the museum, while the cable, in spite of the tremendous inertia of invested capital, is, except in the most congested portions of the larger cities, rapidly giving way before the greater economy of electrical operation. The recent electrical equipment of the extensive Pittsburg cable systems, involving the abandonment of an investment of many millions of dollars, may be instanced in this connection.

The field for future development in electric traction lies in two distinct directions: in the first place, in the equipment and operation of that recent but now most important factor in transportation—the light or secondary railway, which will in time take form as a network of feeders and channels of distribution for the large centres of population and the great trunk railways; in the second place as the successor of the steam locomotive in the operation of the trunk systems themselves.

It is in the first direction in which already some development has taken place that we may expect the most substantial immediate progress. The possibilities of the light railway have of late been the subject of anxious and careful scrutiny on the part of political economists in England and on the continent generally, as a possible relief for the present acute and world-wide agricultural depression. Without going into the social or economic phases of the question it seems undoubted that from all the large centres of population and production we may expect to see systems of light railway lines radiating to the limits of their spheres of commercial influence and affording at a minimum of cost an adequate means for transportation and interchange of the products of the farm on the one hand, and of the factory on the other.

For such a system requiring a frequent and flexible but not a heavy or high speed service no enormous investment of capital would be required. The use of the public highway would save the otherwise heavy outlay for right of way, and its grade could, for the most part, be conformed to. The track and roadbed, even with rails heavy enough for standard freight cars, can, it has been shown, be laid for little more than the cost per mile of a first-class macadamized roadway. The depreciation charges, under normal conditions, would be certainly no greater, and the cost of equipment and operation with electric power, even with the transmission limit of our five hundred volt direct current apparatus, such as to render practicable the working of such systems over a considerable range. We have in Canada several examples of this class of railway, as yet on a limited scale, but in each case affording facilities for transportation, both of passengers and light freight, recognized as being of the utmost value to the public. Each of these roads are, it is encouraging to note, yielding a fair return for the money invested. In the same way the branch lines and feeders of the trunk railways, which are now operated in many cases at a loss, mainly by reason of the inadequate service to which they are limited by the use of the steam locomotive, would, if electrically equipped for a light and frequent service, become a productive part of the system to which they stand at present in the relation of a necessary evil.

It seems, therefore, reasonably clear that in the development of the system of secondary railways which are coming into being as the result of a pressing economic necessity, the electric motor is to find a new and widely extended field of usefulness. The great desideratum at present for this work is a successful alternating railway motor which, it is safe to anticipate, will be added to the list of standard equipment in the very near future. Under present conditions, while the use of the booster or of polyphase transmission apparatus with rotary transformers has made commercially possible the supply of current for distances up to twenty miles, or even more, from the power house, their availability has been lessened by the drawback of excessive loss in the one case and of great cost in the other.

Before leaving this part of the subject, however, it would be as well to point out, in view of the alacrity with which the possibilities which we have been discussing are being taken up as a new and promising field for the exercise of their peculiar abilities by the versatile and talented class of gentlemen known as promoters, that there is no reason to suppose that such a wholesale programme of light railway construction and conversion of existing steam branches would be an immediately profitable or possible undertaking. In many cases the gains made will be in the form of a general public benefit rather than a concrete return in dividends for the money invested. The smaller and more profitable openings for the construction of these lines will afford a field for private enterprise, but any comprehensive scheme will undoubtedly demand in the form of governmental aid, the support of the public, who will be its main beneficiaries.

We may now consider briefly the position likely to be attained by the electric motor as a successor to the steam locomotive in the operation of the great trunk lines. Here the conditions differ materially from those which have led in so short a time to a practically complete possession of the field of street railway traction, and which seem likely to produce similar results in the case of the secondary railways. It must be conceded that no opening or necessity exists for the construction of new trunk lines operated electrically in competition with existing steam roads. The eventual triumph of electricity over steam, for heavy locomotive purposes will come in due course as a result of the establishment of its superiority for the service, but its general adoption will be delayed beyond that point by a natural reluctance to wipe out the capital represented by existing equipment. It must be recognized that the evolution which attends all branches of mechanical development has produced in the steam locomotive of to-day a type admirably adapted to the work which it has so far been called on to perform. It is in the continual demand on the part of the public, for higher and higher speeds between terminal points, and the still more imperative necessity in the face of keen competition and lowering rates for a reduction of operating expenses to the minimum point, that we may expect to find ultimately the most favorable contributing cause for the general adoption of electric motive power on the trunk systems. The direct rotary action of the electric motor and the practical limitation of its power only by the capacity of the stationary source of supply entail the possibility of an increase in rates of speed up to the highest point at which a perfectly constructed roadbed without grades and curves will hold a car on the track. A recent study of the operation of the Pennsylvania Railway would seem to show that such savings in fuel, labor and maintenance accounts would follow its re-equipment for electric traction as to make it commercially desirable, even under present conditions.

It is no extravagant prediction to say that members of this Association who witnessed, in 1885 and '86, at the Toronto Exhibition, the modest beginnings of electric traction in Canada will see it supersede the steam locomotive in the operation of the Canadian Pacific and Grand Trunk Railway systems.

SPARKS.

The employees of the Toronto Street Railway Company held their annual pic-nic a fortnight ago.

Messrs. Folger Bros., of Kingston, Ont., will probably make a bid for the Watertown electric railway, which is now in the hands of a receiver.

The Ætna Boiler Company, of Toronto, Ont., is applying for a charter of incorporation. The capital stock is $20,000, the objects of the company being to manufacture the Ætna safety water tube boiler.

The Hamilton Radial Railway Company have closed a contract with an American firm to fit a number of cars with a patent air-brake that will stop a car going at full speed in one car length without injuring the mechanism.

The Canadian Telephone Company, with a capital stock of $10,000, and headquarters at Sawyerville, Que., is applying to be incorporated for the construction and working of a telephone system in the county of Compton and other counties in the Province of Quebec.

The large fly-wheel of the engine in the H., G. & B. power-house at Stoney Creek burst recently, a piece of the wheel going through the roof, and another portion smashing through the floor. Besides the damage to the wheel and the building, the switch-board was injured. Power was obtained from the Street Railway Company until the H., G. & B. Company got another engine running. About $3,500 damage was done.

Compared with other large towns, London is easily at the head for the magnitude of its electrical supply. Paris, for instance, has only an equivalent of about 500,000 eight-candle power lamps, as compared with the 1,200,000 lamps in London, as stated above. Manchester and Liverpool have, respectively, about 92,000 and 54,000; Glasgow, 70,000; Edinburgh, 43,000; Dublin, 16,000, and Cardiff, 9,000. Of the total capital expended in the whole of the United Kingdom for supplying electricity, London has spent more than one-half.

The new power house of the Trenton Electric Company at Trenton, Ont., was formally opened a fortnight ago. The building is a large and substantial one, erected on the Trent river a short distance east of the G.T.R. station. The roof and sides are covered with iron sheeting. The water wheels consist of two 150 h.p. vertical turbines, manufactured by the Wm. Hamilton Co., of Peterboro. They are geared directly to a large 6 in. line shaft, which runs the whole length of the building. A convenient arrangement is made by providing each of these wheels with a friction clutch, whereby each may be used independently of the other. The two large generators are 200 h.p. each, bolted direct to two pulleys on the line shaft 8 ft. in diameter. The switch-board, 6 x 7½ ft. in diameter, consists of three polished panels of white marble, on which are mounted the various instruments, switches, regulators, etc., necessary for the controlling of such a large plant.

SPARKS.

W. H. Train, of Burk's Falls, has recently ordered a 500 light increase to his direct current incandescent plant from the Canadian General Electric Co.

The capital stock of the Lachine Rapids Hydraulic Co. has been increased to $2,000,000. The new stock has all been taken up by the present shareholders of the company.

Thos. Andrews, of Thornbury, is installing a five hundred light alternating plant to furnish incandescent lighting in Thornbury and also in Clarksburg, distant about one mile. The Canadian General Electric Co. are supplying the apparatus.

The Trenton Electric Power Company has been given the contract for lighting the city. The franchise extends for twenty years, and gives them the right to erect poles on the city streets for the purpose of supplying light, power and heat.

Jas. Playfair, of Midland, has closed a contract with the Canadian General Electric Co. for a plant to be installed on the steam barge "Hall." Both arc and incandescent lights will be used; the former for lighting the docks at which the steamer is loading.

D. Knechtel, of Hanover, is extending his monocyclic circuit to Carlsruhe, a distance of three and a half miles, and to Neustadt, a distance of 7½ miles from the power house. This extension is an interesting evidence of the range over which current may be profitably distributed from a modern alternating system.

The report of the General Electric Company of New York for the fiscal year ending January 31st last, shows the business secured to have been less than 10 per cent. greater in value of sales than for the year previous. The gross earnings were $13,515,667 and the gross expenditure $11,910,240. The deficit increased $877,645. The net loss of liquidation, now charged to the $2,000,000 special allowance after January 31, 1895, was $530,152. The company has no notes payable outstanding, nor is any paper bearing the company's endorsement under discount. The report recites the fact of the contract that has been concluded with the Westinghouse Electric and Manufacturing Company. The foreign business of the company has shown a gratifying increase.

The Niagara Falls Electric Light & Power Co. are making extensive additions and changes in their plant, involving an expenditure of over $25,000. A handsome new power house of pressed brick is in course of erection in a central locality where an ample supply of water can be obtained for condensing. The steam plant will consist of two 200 horse-power compound condensing Wheelock engines. For the incandescent service an order was given to the Canadian General Electric Co. for two 120 kilowatt single-phase alternators. In case a demand for power arises, it is intended to install a 500 volt direct current power generator. The switchboard is to be of white marble, and the instruments and their arrangements are of the most modern design. A system of three wire secondary mains is being installed for distribution through the central part of the town. The work is being carried on under the supervision of Mr. Geo. Foster, the superintendent of the company.

SPARKS.

The Imperial Electric Light Company, Montreal, has been incorporated.

The city council of Toronto is advertising for tenders for the privilege of operating a telephone system for a term of five years.

The Hamilton Radial Electric Railway Company expects to have the line to the Beach in operation by July 15. The power house is ready for the dynamos.

It is understood that the authorities of Montreal have under consideration a scheme for the conveyance of prisoners to and from the jail by means of a trolley car.

The annual meeting of the Nova Scotia Telephone Company was held in Halifax early in June. Gratifying reports were presented by the manager and directors. The board of directors were re-elected by unanimous vote.

The imperial government is building a powerful electric light plant at Fort Clarence, Halifax, entirely concealed from view and protected by earth and masonry. The object of the installation is to obtain a revolving search light of great power to control entrances by eastern passage and Drake's passage, also all the western entrances north of York Redoubt.

The annual meeting of the Kingston Light, Heat and Power Company was held on the 3rd of June. The following were elected directors for the ensuing year: M. H. Folger, B. W. Folger, F. A. Folger, F. A. Folger, jr., R. T. Walkem, W. F. Nickle, I. A. Breck, J. Minnes, W. McRossie. R. T. Walkem, Q.C., was chosen president; I. A. Breck, vice-president, and F. A. Folger, managing director.

Messrs. William Mackenzie, manager of the Toronto Street Railway, and James Ross, managing director of the Montreal Street Railway, have made an offer of $2,500,000 for the Birmingham, England, Tramway Company's franchise and plant. The directors of the Birmingham company have reported in favor of the acceptance of the offer. If the road be purchased, the present system will be changed to electricity. Great Britain is said to possess only about 75 miles of electric road.

Mr. John Peck, manager of the Reid & Currie Iron Works, New Westminster, B. C., has invented an improvement in compound engines, which consists in having but one valve to distribute steam to the two cylinders, and which does away with one link, one set of eccentrics, and the pipe which, in ordinary engines, carries the steam from the high pressure to the low pressure steam box. By this means, it is claimed, there is a great saving in condensation, which, of course, means a considerable saving in fuel.

The case of the Auer Incandescent Light Manufacturing Company vs. O'Brien was heard before Mr. Justice Burbidge in the Exchequer Court, Ottawa. In this case the Auer Light Company sue for an injunction, to restrain the defendant O'Brien from infringing patent No. 46,946. The motion was by the plaintiff, for an order to have defendant produce the sample of the fluid used in manufacturing the "hoods" used in the light. Mr. Duclos, of Montreal, in support of the motion, urged that his client could not go to trial without the samples. Mr. O'Gara, Q.C., opposed on the ground that supplying samples would betray his client's secret; judgment reserved.

After investigation into the circumstances of the recent Point Ellice Bridge disaster, at Victoria, B.C., the coroner's jury has rendered a verdict holding the Consolidated Railroad directors responsible for the lives of persons killed. The city council was arraigned as guilty of contributory negligence and the officials of the corporation were absolved of personal responsibility. It was found that the bridge was safe for ordinary traffic, and the accident would not have occurred but for the improper crowding of the cars which went through the structure. The bridge was found not to have been constructed according to original specifications.

A basis of agreement has been reached between the City Council and the Hamilton Street Railway Company regarding a change from the terms of the by-law. The following reductions on the company's percentage will be made: Up to $125,000 of the gross receipts, from 6 to 5 per cent.; up to $150,000, from 6½ to 6 per cent. On the mileage the company will save about $6,100 a year. The company, on the other hand, agree to give seven unlimited tickets for 25 cents, and nine limited tickets for 25 cents; school children's tickets, ten for 25 cents; a return trip to and from school, 5 cents. The committee will also recommend that the franchise of the company be extended five years, from 1913 to 1918. By the reduction in the price of tickets the company claim to be giving to the public $8,100 annually.

The rate of transmission on Atlantic cables is eighteen words of five letters each per minute. With the "duplex" this rate of transmission is nearly doubled.

VIBRATION AND CONDUCTIVITY.—Signor Murani, in L'Elettricista, describes experiments on the influences of vibration on the resistance of wires. To avoid the heating due to friction, the vibrations in a series of metallic wires were induced by an electromagnetic tuning-fork, wires of hardened iron, platinum, hard steel, hard copper, German silver, and manganin being tested, and in no case was any variation in the electric resistance detected by the most delicate methods. It is consequently concluded that the resistance of metallic wires is not altered by vibrations, all results to the contrary obtained by other observers notwithstanding.

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During 1895 electric lines in Europe increased in number from 70 to 111, with a total length of 560 miles.

The shareholders of the Hamilton, Grimsby and Beamsville Railway have decided to extend the line to Grimsby, to be completed by 1st November of this year.

The Lake Superior Power Company, of Sault Ste. Marie, Ont., will go extensively into the production of calcium carbide, the substance from which the new acetylene gas is manufactured.

Mr. B. B. Osler, Q.C., president of the Hamilton & Dundas Railway Company, has under consideration the question of changing the road to an electric line. It is said to be the intention of the company to commence operations as soon as Mr. Mackenzie returns from England. The estimated cost of changing the system is placed at $50,000.

Mr. Hugh Neilson, chief electrician of the Bell Telephone Company, was in Quebec recently to report on the construction of a telephone line from Quebec to the Island of Orleans. In company with Mr. Dauphin, local manager at Quebec, he examined the site for the cable, from L'Auge Gardien to St. Pierre, and will, it is said, report favorably to the company.

A dispatch from New York dated June 30th says: The contract for the entire development of 20,000 horse power on the Richelieu river, the outlet of Lake Champlain, has been let to the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio, for $550,000, the electric machinery not being included. This power is to be carried to Montreal by wire and electrically distributed, the distance being about twelve miles. This is the second electric water power development in Montreal, the first being for 12,000 horse-power at the Lachine rapids, five miles above the city, in the St. Lawrence river, for which the Dayton company also have the contract. The investment in both powers will be about $3,500,000, all subscribed for by Montreal capitalists.

The Cornwall Electric Street Railway Company formally opened their line on June 30th. The main line down Pitt street, the belt line to the East Ward, via Second, Marlboro' and Water streets, and the line down the front road to the St. Lawrence Park on Gillespie's Point, have been completed, making in all about five miles of track. The line to the Toronto Paper Company's mills in the western suburbs, Smithville, and the branches to the textile mills, remain yet to complete. The plant is up-to-date in every respect. The cars, which are of the latest models, were built in Deseronto, and the machinery was put in by the Canadian General Electric Company. The Street Railway Company have purchased Gillespie's Point, a short distance below the town, and have fitted it up in an elaborate style as a pleasure resort, to be known as St. Lawrence Park.