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CANADIAN ELECTRICAL NEWS AND ENGINEERING JOURNAL

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DECEMBER, 1900

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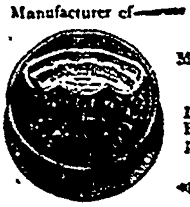

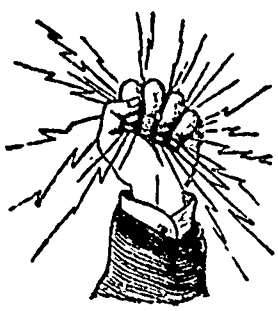

ELECTRICAL MATTERS IN THE EAST.

[By a Travelling Correspondent.]

In an admirable location, at 72 Prince William street, Mr. R. E. T. Pringle, the well-known dealer in electrical supplies, of Montreal, has opened a branch in St. John, under the efficient management of Mr. G. E. Rough, who is now in charge. The warerooms look out upon the best business street in the city, and are large and well lighted. The main room, which is filled with a complete line of supplies of all kinds, is 30x75 feet. In this Mr. Rough has his office. As Maritime Province agent he will distribute from here, but while doing jobbing, will not contract. His stock includes about everything necessary to the electrical trade, including wire, lamps, transformers, meters, fixtures, shades, etc. A specialty which he is carrying is the Scheeffer meter, for which he claims great success. Mr. Pringle made a good move in opening a branch down here, as it has been greatly needed.

There is little prospect of the street railway in Moncton being opened in the near future, and to my mind, the failure of the concern to make a success in operation should have been foreseen. It never paid running expenses, nor could it be expected to where the one continuous line enclosed but a small block which the public can walk across in a few minutes. Had the line been carried out to some of the small outlying villages there might have been some chance, but these places are comparatively small.

The Moncton civic electric light plant, of which Mr. John Edington is manager, is just putting up a new incandescent circuit of about 1,000 lights. They have two men engaged steadily installing the new lights, and have placed about 500 this summer. They thought of putting in an S.K.C. alternating dynamo, but have given up that idea for the present.

Mr. McGinn, who has been for a long time in charge of the electric lighting station in Fredericton, has resigned and will go on the road as traveller for the A. B. McLean Co., of St. John.

The Robb Engineering Company, of Amherst, whose engines are so widely known, secured an order a week or more ago for a 250 h.p. engine which is to be shipped to Calcutta. Another order is for a portable mill, engine and all fittings of large and heavy capacity which are to be shipped by its purchaser, Mr. Clifford Patterson, to the Chilliwack Valley in British Columbia, where a firm which that gentleman represents is beginning large lumbering operations. The transcontinental freight on this order will be something between $800 and $1,000. The firm has been rushed with business lately.

Another year may see steps taken by the town of Pictou to equip itself with an electric lighting system. Hitherto gas has been used there entirely. Mayor Craig has expressed himself as decidedly in favor of the installation of an electrical plant, and if that gentleman is continued in office the matter will be brought up as an issue next year. The town is now engaged in the securing of an efficient water supply, tenders for which work are about to be asked for.

It is expected that some important changes will soon be made to the electric plant at Springfield N.S.

The village of Oxford, N.S., will soon have a better system of electric lighting than the old one, good as that has been in this thriving little town. The old plant, a small one run by water-power from a falls in the town, and under the charge of Mr. S. E. Hue, will be done away with. The Oxford Electric Light Co. is putting in a new Royal Electric S.K.C. dynamo of 600 lights capacity, and a new engine of 60 h.p., which has been placed in the engine house of the American Furniture Company, and is supplied by a new boiler of 125 h.p. A large number of electric lights are being added. Among those composing the company are: Messrs. H. C. Hewson, president; Geo. White, secretary; directors, E. G. Langille, A. M. Ross and A. M. Henderson. The Oxford Foundry & Machine Co. have their own lighting plant. The American Furniture Co. will equip their factory with electric lights from the town system.

Parrsboro was the first town in Nova Scotia to put in and operate its own electric light plant, and I am informed that the venture has given satisfaction, and that it is likely to be profitable to the ratepayers as well as to the consumers of light. They are lighting their streets with 25 1200 candle power arc lamps, at a cost to the ratepayers of $600 per year, while the ordinary 16 c.p. light in a dwelling house costs 25 cents per month. Their supply of power and light was found inadequate for the demand, and they are now adding another S.K.C. generator and equipment from the Royal Electric Co. and a Robb-Armstrong engine. This will increase the number of lights by 1,200. They have now 950 lights contracted for, but the demand was so great that they were compelled to add the second power of 1,200 lights that they might be able to supply the town's further demands for more light. Their system, I am told, is all that could be wished for, and the management the best. Councillor Wheaton and superintendent Jules Choisunt have devoted their best efforts towards its success.

A.B.P.

The new lamp invented by Messrs. F. W. Martin and Frank Stewart, of Hamilton, is now being manufactured by the firm of Brown, Boggs & Company, who now have in course of erection a three-storey addition to their factory.

The Gravenhurst Electric Light and Power Co., who were unfortunate enough to have their lighting station destroyed by fire in October, are rebuilding their plant on a more extensive scale, as they have secured the lighting of the sanitarium, which requires an additional capacity of 250 lights. The order for the 75 K.W. S. K. C. generator, with the necessary switchboard, etc., was placed with the Royal Electric Company, and the plant is again in operation.

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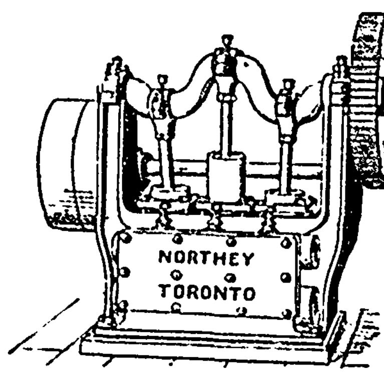

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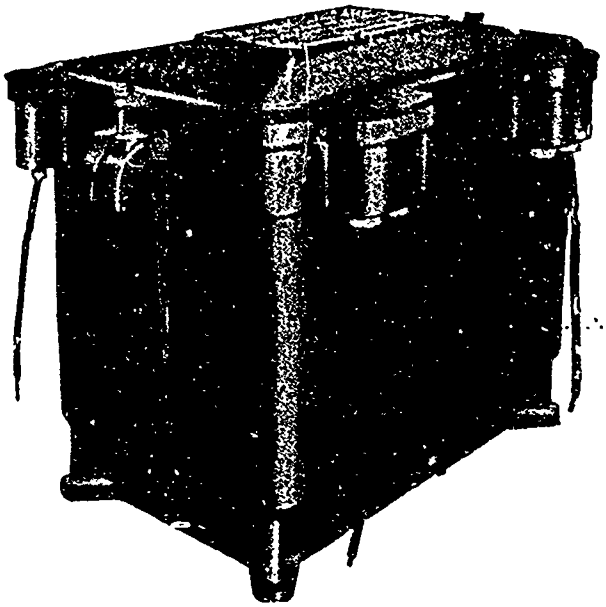

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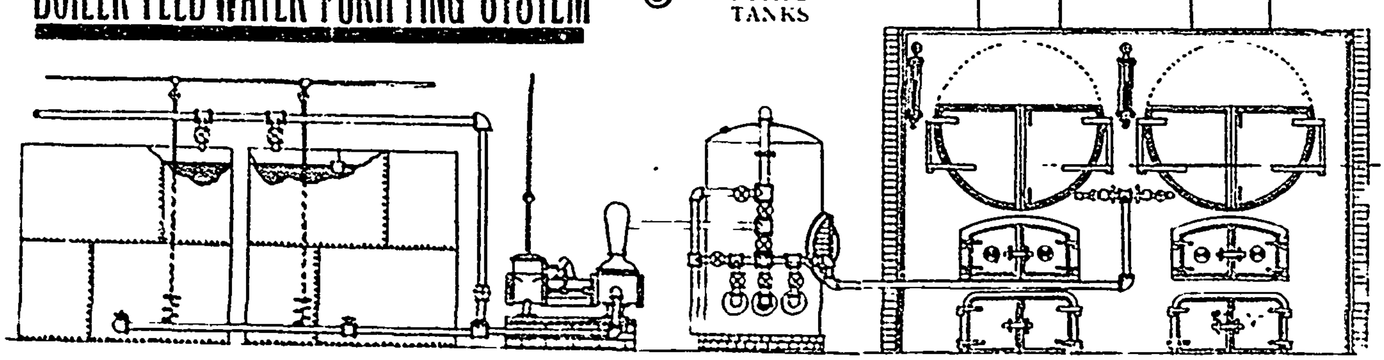

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CANADIAN
ELECTRICAL NEWS
AND
ENGINEERING JOURNAL.

VOL. X. DECEMBER, 1900 No. 12.

ELECTRICAL EQUIPMENT OF McDONALD ENGINEERING BUILDING AT McGILL.

THROUGH the munificence of Sir W. C. McDonald, the authorities of McGill University, Montreal, have been enabled to erect and equip a building for the study of engineering which is one of the most complete institutions of the kind in America. Of pleasing architecture, *the exterior is at once admired, while the interior arrangements* and equipment command equal praise. The electrical equipment of the McDonald Engineering Building, as it is called, was described at some length in the ELECTRICAL NEWS of May, 1898, but since that time extensive alterations and additions have been made, as will be seen from the following particulars and accompanying illustrations of the equipment as it now stands:

The power station, the heart of the institution, is well shown in the illustration on this page. In this room all the electric power is generated which is used in the building for lighting and power and for the laboratories and test rooms. It differs in one important particular from a power house for purely commercial purposes, inasmuch as there has been no attempt at standardization in the units adopted as regards the type, the reason obviously being that it has been considered advisable to bring under the notice of the student as many different types of apparatus as possible. *Consequently, side by side will be found a Robb*-Armstrong engine driving a 75 k.w. direct current 110 volt Crocker Wheeler generator, while opposite is seen a similar size Ideal engine, by Goldie & McCulloch, driving a 75 k.w. Canadian General Electric Company's machine of the same voltage.

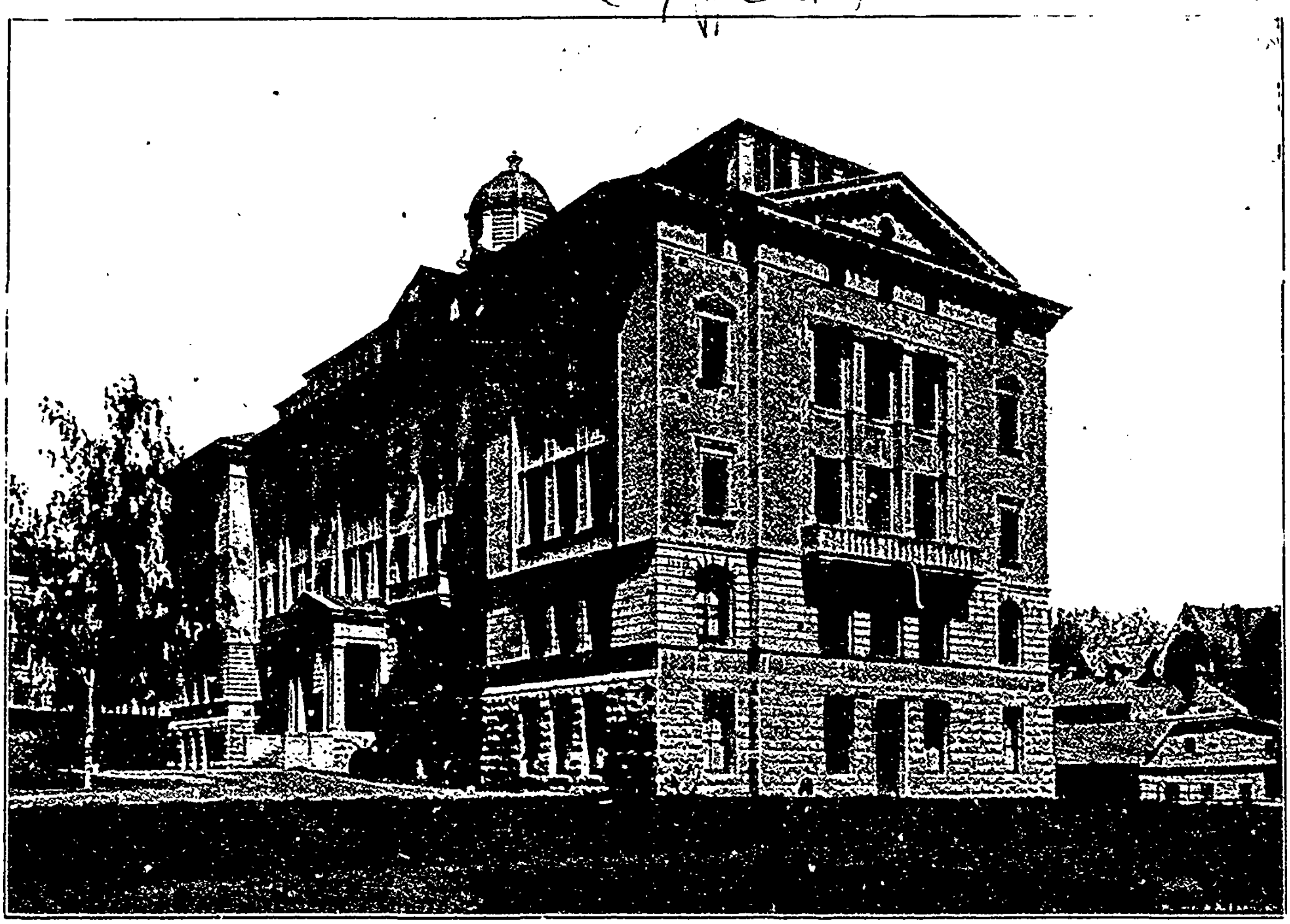

FIG. 1—MCDONALD ENGINEERING BUILDING, MCGILL UNIVERSITY, MONTREAL.

Great Britain is represented by two Willans engines driving a Siemens and a Mather & Platt direct current 30 k.w. 110 volt machine respectively. All or any of these machines may be used for either lighting and power for the general uses of the building, o for the laboratory testing purposes, through a four pa ! switch-board.

In addition to the above, a storage battery has been installed for the purpose of lighting the building when the plant is not running, and for charging purposes a Sprague motor generator is used to raise the voltage about forty volts over the 110 volts of the dynamo plant. The absence of wires is noticeable, all wires and cables being carried in ducts under the tessellated floor, but as these ducts are covered by iron plates they are as readily accessible as if exposed in the unsightly manner so often adopted. In short, the well lighted, airy, clean power house with all necessary appliances, but without any gingerbread fittings for show, is a model of what such a plant in an educational institution should be.

Probably the most important part of the laboratory which is intended for the education of practical engineers, is what is called the commercial laboratory, and it is well named, for not only are all classes and types of machines here gathered together, but are noticeably nels under the raised floor upon which the machines are set. This floor being equipped with slots and plugs like an iron planer table, is suitable for the base of any machine, and also ensures that the belts may be kept tight without unsightly and cumbersome tightening apparatus. Movable tables of solid construction are provided upon which can be mounted the necessary local instruments and switches which may be found necessary for any particular test which may be undertaken.

As will be seen by the illustrations (Figs. 3 and 4) this laboratory is divided into sections called the alternating current room and the direct current room. While really the same room, these names are adopted to indicate the classification of the apparatus, for on the one side the alternating current dynamos driven by direct current motors are placed, while on the other the direct current generators and arc machines are set, and as each of these sections has its own travelling crane,

FIG. 2.—GENERATOR ROOM, McDONALD ENGINEERING BUILDING, McGILL UNIVERSITY.

arranged for commercial work in the most practical way. The test room of a manufacturing establishment, and the usual college laboratory, are generally very dissimilar; the one bearing evidences of the hasty and unscientific methods which are apt to prevail in a commercial establishment, while the other very often partakes of the nature of a scientific kindergarten. In this case, the arrangements for good practical engineering work are unsurpassed, not only by reason of the great amount of apparatus, but notably by reason of the thoroughly practical way in which the work can be carried on. For instance, each test can be operated independently of any other without that confusion which would inevitably result from an improper and unpractical lay-out of the apparatus, while flexibility of the apparatus is increased to the maximum by the ease by which the machines may be moved from place to place by the travelling cranes and the facility of connection to the circuits, which run in easily accessible chan- cables switches, etc., the two divisions of the laboratory are independent. The alternating current laboratory containing, as it does, examples of the best types of single two and three phase machines, as well as special apparatus for phase and periodicity changing, is probably the more interesting of the two, while the direct current laboratory contains types which are familiar by long association to any one acquainted with the average lighting and power station for commercial purposes. It may be noted that while the size of the machines is not such as to command attention, the largest unit not exceeding 40 k.w., none of them are toys, but of a size sufficient to demonstrate the peculiar features of each type, and are arranged and connected so that the distinctive features of each may be best shown. A glance at the principal pieces of apparatus will illustrate this fact, for we find driven by appropriate variable speed direct current motors the following types :

A 15 k.w. alternator, with revolving fields, made

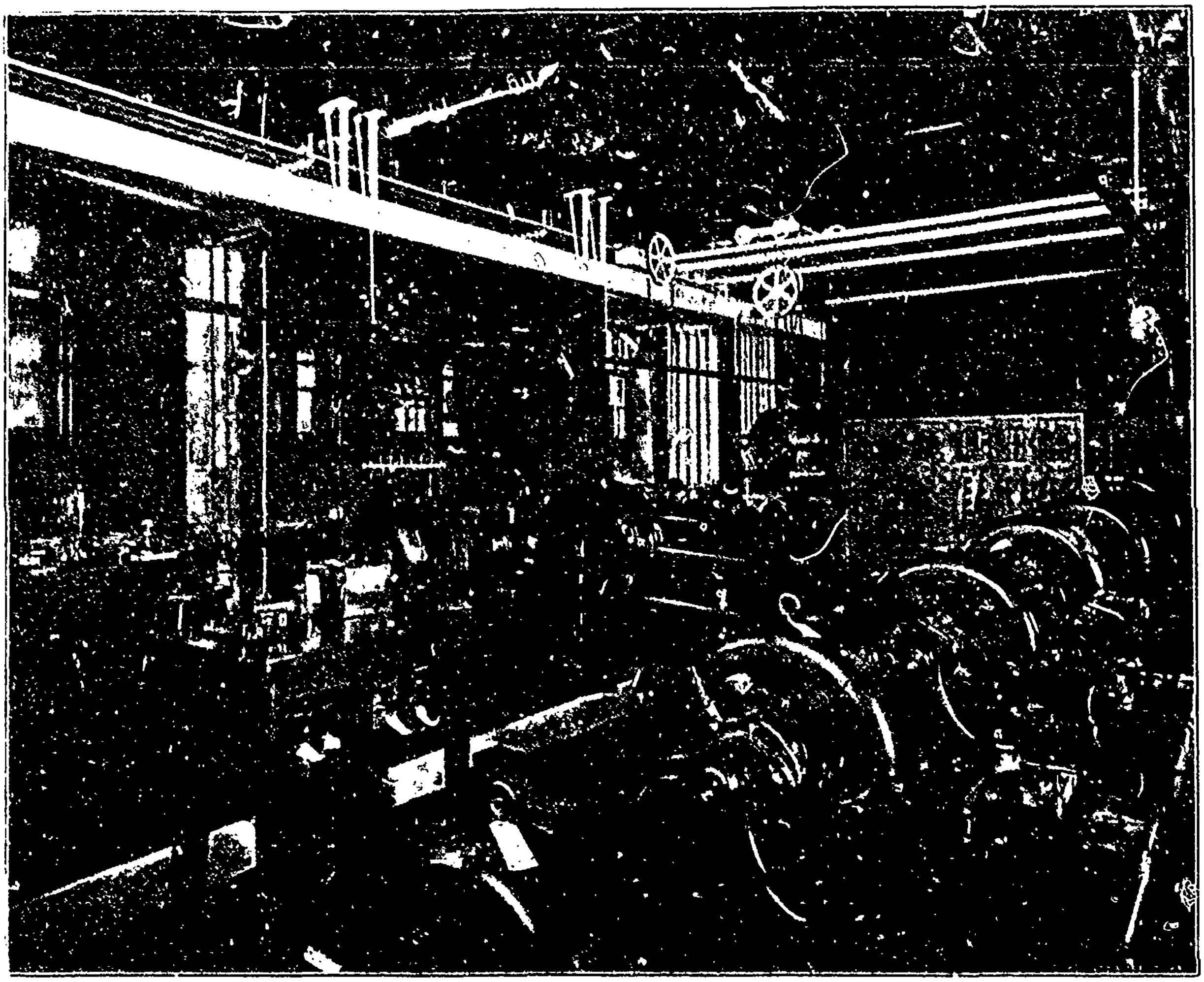

FIG. 3. ALTERNATING CURRENT DYNAMO ROOM, MCDONALD ENGINEERING BUILDING, MCGILL UNIVERSITY.

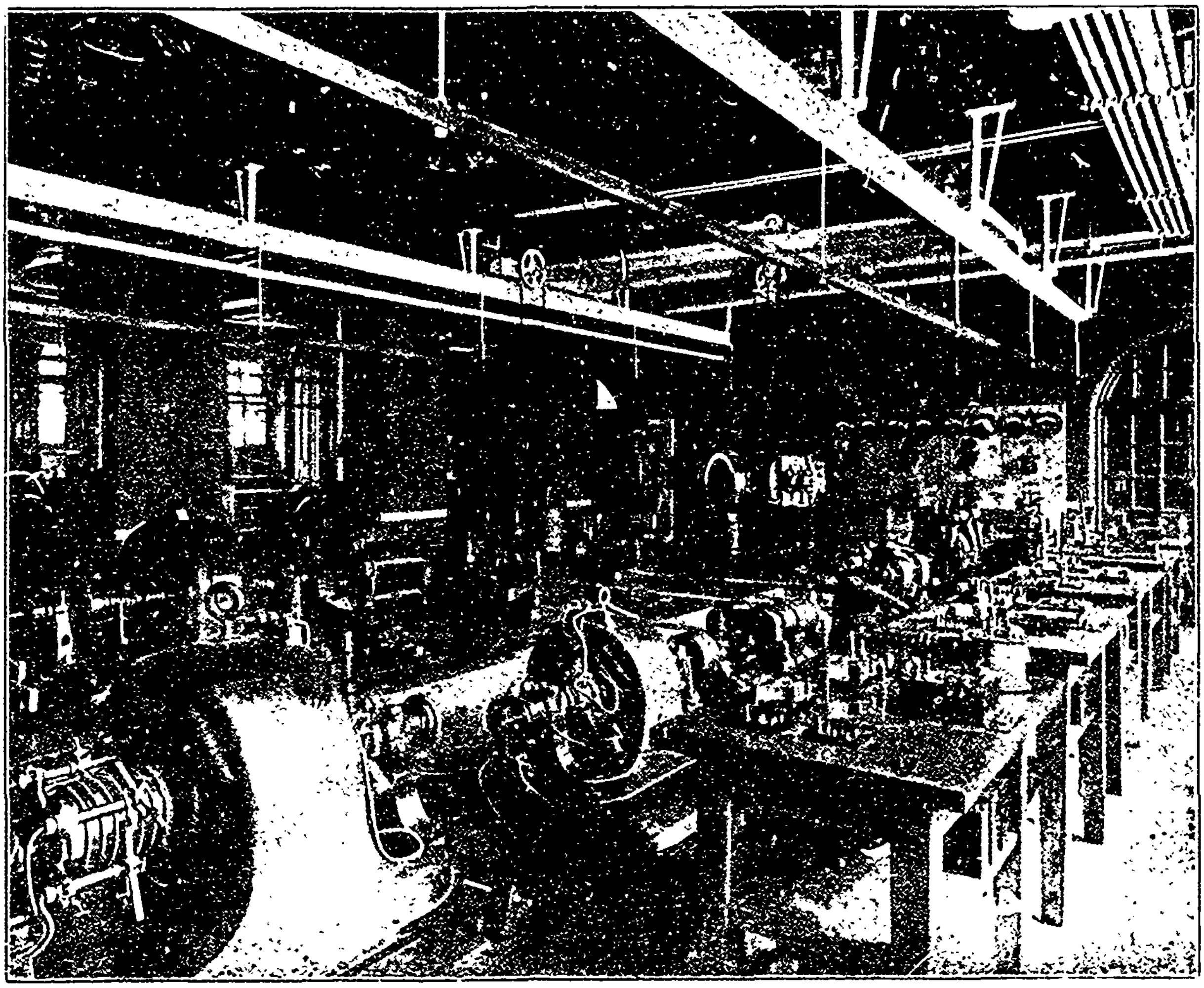

FIG. 4. DIRECT CURRENT DYNAMO ROOM, MCDONALD ENGINEERING BUILDING, MCGILL UNIVERSITY.

by the Canadian General Electric Company which may be used for either single two or three phase operation; a 15 k. w. Stanley two phase alternator, made by the Royal Electric Company, which illustrates the inductor type with stationary armature, a 15 k. w. Warren inductor alternator, for single phase operation, a 12 k.w. Hordey inductor alternator made by the Brush Company; a 20 k. w. one, two or three phase double ended Westinghouse rotary converter, and two others of the same type of 10 k. w. each; a 10 h. p. two or three phase induction motor made by the Canadian General Electric Company, arranged for frequency changer through the variable speed of the driving motor.

In addition there are a number of alternating current motors from two to five h. p., as well as the direct current motors used for the generator drives, which vary from ten to forty h. p., of General Electric and Crocker Wheeler type. The instruments and accessories which which will abundantly satisfy the most enthusiastic student, especially when it is noted that the power station and all the laboratory motors are also of the direct current types.

In addition, there is being installed at the present time a Chloride storage battery of 75 k.w. hour capacity, which is arranged to float on the circuit supplying the laboratory, which absorbs current when the load is light and gives it out when the laboratory demands are great. This battery will thus not only aid the regulation, which is so important where experiments are to be successfully carried out, but will be available for standardizing instruments and similar work where a very steady voltage is required.

The ampere meters, volt meters, condensers, transformers, voltage regulators, electric speed indicators, dynamo meters, etc., are of too great a variety to enumerate, and the resources of European and American

FIG. 5.—HIGH TENSION LABORATORY, MCDONALD ENGINEERING BUILDING, MCGILL UNIVERSITY.

must of necessity be used in the work are of every variety and of representative types, and include a number of special instruments of precision not usually found in the laboratory With the above equipment it becomes easy to meet any case which may arise, and power of any periodicity, phase or voltage is readily obtainable. It is here that the student gets his most practical experience in dealing with alternating currents.

The direct current laboratory, while representative of the older and more similar types of machines, will not demand from the student that study which he will have to devote to the alternating section, but as representing direct current machinery and practice it is very suitably fitted up. A glance at the types shows a 16 light Thompson Houston arc machine, a similar size Wood arc, and a ten light Brush arc machine. Of direct current motors there are many of all types and sizes from one-twentieth to 15 h. p., the latter size being a railway motor. These, with their numerous accessories, such as rheostats, switches, arc lamps, starting boxes, etc., allow of a scope for experiment in direct current field makers have been drawn upon in the largest way to make the auxiliary apparatus complete.

With this commercial laboratory so thoroughly equipped, Professor Owens has at his disposal an instrument thoroughly suitable not only for instructive purposes but also for the commercial testing of lamps, transformers, meters, etc.

The high tension laboratory, with its transformers wound as high as 30,000 volts, its electrostatic instruments for measuring pressures of 150,000 volts, with accessories in the shape of meters, regulators, impedence coils, etc., is evidently no place for the freshman of an investigating turn of mind. It is here that all high voltage experiments are carried out, line insulators tested, and completed apparatus subjected to the searching thrusts of thirty thousand volts or so. To the high potential laboratory is due the advances in insulation which have made it possible to transmit power to long distances at high voltages, and it is this department which will be called upon in the future to extend the range of commercial voltages, so that this will be a more important department in the future than seven at the present time.

The standardizing laboratory, where all instruments are calibrated and the most of the high class experimental work is done, is well shown in Figure 6. Here very accurate measurements of voltage, current capacity, self induction magnetization, etc., are made, and it is here that the student receives his training in stats and condensers in formidable array complete the more important apparatus. This is the final court of appeal before which all hysteretic and impermeable irons receive their sentences ; here are dragged all untruthful

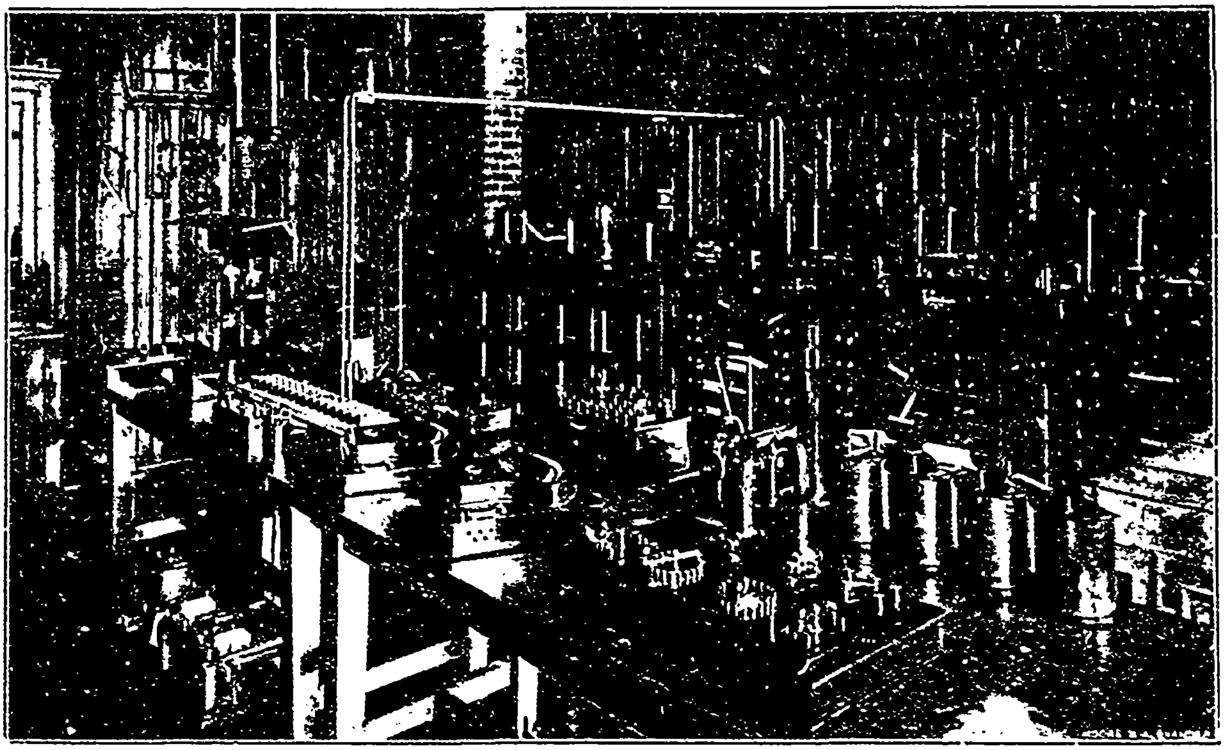

Fig. 6. Standardizing Laboratory, McDonald Engineering Building, McGill University.

the use of instruments which should enable him to carry on the work of original research. In this department are to be found standard Kelvin balances for the measurement of current up to 600 amperes, either direct or alternating, electrostatic and multicellular voltmeters up to 10,000 volts, designed by the same eminent scientist, and perjured ampere and volt meters to have their characteristics examined and their faults corrected.

From the standardizing laboratory the student reaches the original research laboratory, where in his later years he is given a free hand to investigate for himself certain promising fields for which his previous training

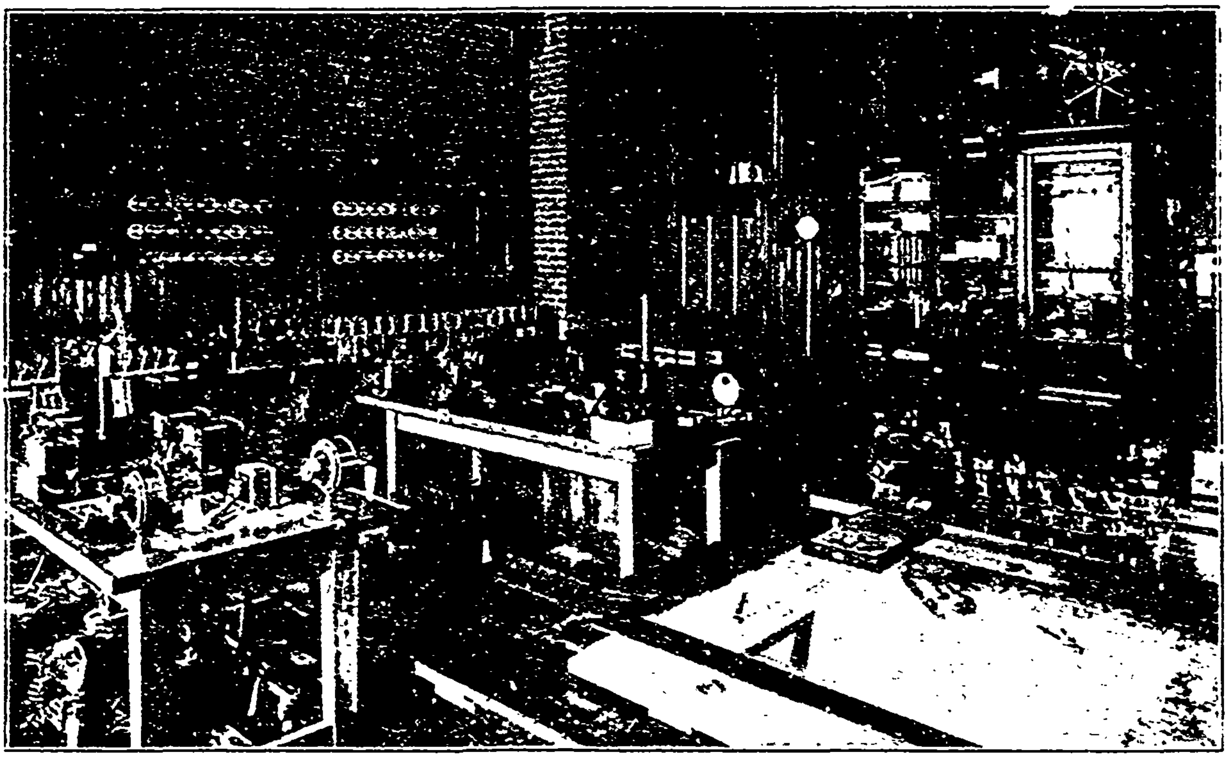

Fig. 7.- Special Investigation Room, McDonald Engineering Building, McGill University.

Thomson and D'Arsonval galvanometers, standard cells, wheatstone bridges and potentiometers, standard resistances, and a multitude of standard voltmeters and ampere meters. For the testing of irons there are permeability bridges and hysteresis meters designed by Ewing, and special transformers, phase shifters, rheo- has fitted him. Several special instruments are here placed, but the greater portion of those here used may be drawn from the other departments as required. In addition we should mention the shops where skilled mechanics repair and construct special apparatus for the use of the laboratories.

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The Growth of Electrical Engineering.

REFERENCE was made in our last issue to the large number of fourth year engineering students at McGill University who are taking the electrical engineering course, the proportion of such students being sixty per cent. of the fourth year men. We learn on subsequent enquiry that at the School of Practical Science, Toronto, a still larger proportion, namely, 62½ per cent. of the senior students, are taking the course in electrical engineering.

A Misrepresentation.

The ELECTRICAL NEWS has been advised that a representative of a certain trade journal who is now travelling in Great Britain has represented to British manufacturers of electrical supplies that there is an enormous field for their goods in Canada. As a consequence, advertisements have been placed in the said journal, and the representative in return has furnished to the British manufacturer the names of Canadian supply houses, to whom letters have been sent offering electrical goods. It is to be regretted that the actual situation should be misrepresented. It is well known that the demand for British electrical goods is exceedingly light in this country. Take, for instance, incandescent lamps; the bulk of those used in Great Britain are manufactured outside of the country, while the T.H. base so much used here is practically unknown there. So with sockets. Owing to their using more keyless than key sockets, the shades are generally not arranged for a holder, but with a hole in the centre, the same as for the Edison old style systems here. The difference between wire gauges here and in Great Britain is likely to result in errors occurring in orders, as the buyer here is more accustomed to the B. & S. than to the B.W.G. Considering the population, there is indeed a large consumption of electrical goods in Canada, but before British firms can secure a reasonable share of the trade it will be necessary to introduce a number of important changes in manufacturing methods. If their goods are manufactured to meet the requirements of the Canadian trade, there is no reason why British manufacturers should not increase their exports of electrical goods to this country, as witness the large quantity of these goods now imported from the United States and Germany. But the persons to properly develop the trade are those versed in electrical matters, while the prospects of business are lessened by the tactics of the journal above referred to.

A 150-Mile Transmission.

WITH the immense water power of the Niagara Falls situated about eighty miles from the city of Toronto, the undertaking of the Standard Electric Company, of California, has a peculiar interest for Toronto citizens, and especially at the present time when the necessity of cheaper power for our manufacturing industries is so fully recognized. In the project of the Standard Electric Company we have an object lesson which may encourage the development of Niagara power. It should be stated, however, that in California the cost of coal is much greater than in Ontario, giving a water-power plant there an advantage over steam which would not apply in the case of transmitting power from Niagara Falls to Toronto. The power house of this company is located at Blue Lakes, and for some time electric power generated at this point has been transmitted to Stockton, forty-six miles distant. The ultimate intention is to transmit the power to San Franscisco, a distance of one hundred and forty-five miles, for which purpose a plant is now nearing completion. In addition to being the longest transmission line ever operated commercially, the plant will be distinctive for two other reasons, first, that the current will be transmitted at a pressure of 60,000 volts, which is twice as high as has heretofore been attempted, and, secondly, that aluminum wire will be employed as the conductor. The high voltage employed will necessarily reduce the cost of the transmission line. This is one of the advantages claimed for aluminum as a conductor. The relative merits of copper and aluminum for the transmission of electricity have been much discussed of late, and it cannot fairly be said that the experiments thus far with aluminum have shown it to possess an efficiency equal to that of copper, while its resistance to atmospheric influences is not as great as was at first supposed. The companies in America who have employed aluminum wire are the Snoqualmie Falls Power Company, a 34 miles transmission, with 29,000 volts; North Yuba Power Company, of Sacramento, 63 miles; Hartford Electric Light Company, 11 miles, 10,000 volts; Cottonwood Power Company, of Utah, 12,000 volts; Telluride Power Company, of Provo, Utah, 80 miles; Niagara Falls Power Company, for a short transmission; and the Standard Electric Company above referred to. In connection with the transmission of power from Ragged Rapids to Orillia, Ont., it was originally proposed to use aluminum wire, but for some reason this decision was not adhered to. It would seem that the use of aluminum is yet quite experimental, and that its use may develop obstacles difficult to overcome.

Prevention of Smoke.

IN cities where manufacturing is carried on to any extent a question of some moment is the prevention of annoyance from smoke emanating from steam boilers. For three years past a law has been in force in the city of Montreal providing that all steam users must equip their plants with apparatus for consuming the smoke, while a by-law has received its second reading in the Toronto city council designed to accomplish the same purpose. To the latter by-law exception has been taken by the Canadian Manufacturers Association, and rightly so, as in its present crude form we believe the ordinance to be unworkable. It provides that all manufacturers using combustible material to produce heat or power shall apply such apparatus as shall prevent the smoke from fouling the atmosphere, and in the event of neglecting, they are to be subjected to a fine of fifty dollars for each offence. The objections urged against the by-law are that the method of conviction is such as would place manufacturers entirely at the mercy of unscrupulous persons who might from time to time feel disposed to persecute them, and that the by-law should be more explicit and state what device will satisfy the requirements and exempt a manufacturer creating smoke from liability to prosecution. The difficulty of overcoming the smoke nuisance is well illustrated by the experience of cities in the United States. Although in a number of cities such by-laws as the one under consideration are in force, the results in the main seems to have been unsatisfactory. In Rochester, for instance, such a law was enacted twelve years ago, but was subsequently repealed. In Syracuse it is not considered a success, while in Pittsburg, Cleveland and Chicago it is said to have relieved the trouble only in a slight degree. In these cities the duty of enforcing the law devolves upon the city engineer or some other competent person appointed for the purpose. The strongest objection that can be advanced against the enactment of a law such as that framed by the Toronto city council, is the doubtful merits of smoke consumers. The opinion seems to prevail, based upon experience, that of the various smoke consuming devices on the market none will accomplish the purpose for which they are intended, and it is a question in the minds of manufacturers whether the degree of efficiency to which they have attained will warrant the expenditure necessary for their installation. Tests of smoke consuming devices have been made in Toronto with the result of increasing the cost of operating the boilers, without abating the nuisance. To our mind, the prevention of smoke from steam boilers has more nearly reached attainment than the consumption of smoke. The methods of firing boilers have undergone great changes in recent years. With these changes have come better combustion and a decreased quantity of smoke. The automatic stokers have, we believe, accomplished much towards smoke prevention. We are told that by this method of firing, the O'Keefe Brewing Company, of Toronto, have practically overcome all annoyance from smoke, and at the same time have effected a saving of fifteen per cent. in fuel. The trouble may also be diminished by the erection of higher chimneys, by having sufficient boiler capacity so that it becomes unnecessary to force the boilers, and by the ednoation of the boiler attendants. By means of a high chimney a better draft through the furnace is secured. This will assist in relieving the smoke and also effect a saving in fuel. The matter of educating the firemen is one which has received attention in Great Britain, where in some cities the law is such that where the boiler capacity is ample and smoke is allowed to emanate, the fireman instead of the owner is prosecuted for the offence. The Canadian Manufacturers Association have suggested that the city council make a test at the waterworks plant of the various smoke consuming devices, and decide upon one which will meet the letter of the law. This, we think, is placing the responsibility upon the proper shoulders, but we are by no means sanguine that the results accomplished will be satisfactory either to the city council or to steam users, as it seems impossible to select a device that will meet the varying conditions under which different steam plants are operated.

THE CATARACT POWER COMPANY.

The Cataract Power Company, of Hamilton have been making extensive alterations and additions to their power house, distributing lines and transformer station. Having found it necessary to increase their plant, they have just installed two new 3,000 h p. turbines, manufactured in Milan, Italy, two 2,000 k.w. S.K.C. generators, ten 400 k.w. step-up transformers, three 300 k.w. rotary converters, and a chloride storage battery equipment. They have also built a second transmission line of No. 00 copper wire. A new building is nearing completion which will contain the rotary transformers, arc light apparatus, new battery equipment, and the switch-boards. It is the intention of the company to close down the power houses of the Hamilton Electric Light Company, the Hamilion Street Railway Company, and the Hamilton Radial Railway Company, and to distribute altogether from the step-down station on Victoria avenue, the incandescent, arc, power and railway service being supplied from one building.

The generators recently installed are among the largest yet built in Canada, and, we understand, by weight, the largest in North America. Each generator has a capacity of 2,000 k.w., with a large overload capacity. The weight of the generator complete is over 110 tons, or 220,000 pounds, and is similar in design to the 1,000 k.w. machine two of which the Cataract Power Company now have in their station. The total capacity in generators is over 10,000 h.p. The entire machinery throughout has been supplied by the Royal Electric Company, Montreal, and consists entirely of S. K. C. apparatus operating at two and three phase. This is now one of the most complete power stations in Canada, and is giving excellent results.

THE CHAMBLY POWER PLANT.

An unfortunate accident occurred at Chambly early in November, when a portion of the Chambly Manufacturing Company's dam adjoining the power house was swept away. The main part of the dam remained intact, but about 150 feet situated close to the shore and used as sluice gates for waste water was destroyed.

The accident is said to have been due to the water loosening the concrete embedded around the gates. The loosening of the concrete had been noticed, and means were about to be taken to strengthen it.

The lighting service was not interrupted to any extent as the result of the accident, as the steam reserve plant retained by the Royal Electric Company was immediately called into requisition.

In connection with the additional plant about to be installed at Chambly, some important changes will be made. The line voltage will be changed from 12,000 to 25,000 volts, and the generator voltage from 12,000 to 2,000 volts. The line will be changed from four wire to three wire transmission. The four new generators to be installed, and which were referred to in last issue, will be 2,000 k.w., 2,000 volt machines, of the revolving field type, while the new turbines will consist of sixteen 51 inch S. Morgan Smith wheels, with possibly Lombard governors. It is also the intention to put in ten 2,000 k.w., 2,000 to 25,000 volt air blast transformers, and to deepen and widen the trail race.

A BRIEF HISTORY OF THE SCHOOL OF PRACTICAL SCIENCE.

THE banquet to be tendered on December 21st to Professor Galbraith, principal of the School of Practical Science, Toronto, by the faculty, graduates and other graduates, has naturally carried the thoughts of many back to the early days of the school, as almost since its inception the name of Professor Galbraith has been regarded as synonymous with the success of the school. Established in a modest way to meet the demands for technical and scientific education, the growth of the institution has been almost phenomenal, until the increased accommodation provided from time to time is now entirely inadequate.

The present School of Practical Science is the successor of the College of Technology, an institution which was practically an evening technical school for artisans and others, and which occupied the building of the present public library, corner Church and Adelaide streets. The origin of the present school dates from January 30, 1877, when the Legislative Assembly, in accordance with the recommendations of a report to the Hon. Adam Crooks, Minister of Education, by Professor James Loudon, sanctioned the proposal for the permanent establishment of a School of Science, and authorized the erection of a new building upon a site in proximity to the University of Toronto. The character of the institution was greatly changed, and under the new arrangement the chief object of the school became the teaching of engineering and applied chemistry. It was decided, by an arrangement with the Council of University College, to utilize the teaching power of that college which already existed for the like objects in four departments and could be made applicable to the wants of the School of Science, and in addition thereto to appoint a professor of engineering and such assistants as might be found necessary. This arrangement continued until the end of 1899, when the departments of science were transferred from University College to the University of Toronto, under the operation of the University Federation Act. That the students might continue to receive instruction in the above departments in the same manner, the School of Science was affiliated to the University of Toronto.

The building erected at that time forms the north wing of the present school. Besides being the home for the engineering classes, it furnished accommodation for the departments of biology, chemistry, and mineralogy of the University, the engineering department having but one floor.

PROF. GALBRAITH,
Principal School of Practical Science, Toronto.

The first calendar of the School of Practical Science is denoted as the session of 1878-79, and the faculty consisted of H. H. Croft, D.C.L., professor of chemistry; E J. Chapman, Ph.D., LL.D., professor of mineralogy and geology; James Loudon, M.A., professor of mathematics and natural philosophy; R. Ramsay Wright, M.A., B.Sc., professor of biology; J. Galbraith, M.A., Assoc.Inst.C.E., professor of engineering; W. H. Ellis, M.A., M.B., assistant professor of chemistry. The attendance at the school in this year was six students.

From the calendar we notice that there was three courses, namely: (1) engineering; (2) assaying and mining geology; (3) analytical and applied chemistry. Regarding the engineering course, it is stated that in the absence of a machine shop visits to workshops and excursions during the long vacation will be taken advantage of.

An important event in the history of the school occurred on November 6th, 1889, when Professor Galbraith was appointed principal and the management of the school entrusted to a council composed of the principal as chairman and the professors, lecturers, and demonstrators appointed on the teaching faculty of the school. Recognizing the necessity of embracing every branch of applied science, the principal decided to extend the curriculum of the school so as to embrace five regular departments of instruction, in each of which diplomas would be granted, namely, (1) civil engineering (including mining engineering); (2) mechanical engineering (including electrical engineering); (3) architecture; (4) analytical and applied chemistry; (5) assaying and mining geology.

In 1889-90 the management of the school was entrusted to a council of five, consisting of Professors Galbraith and Ellis, and Messrs. C. H. C. Wright, B.A.Sc., lecturer in architecture; T. R. Rosebrough, M.A., demonstrator in engineering; and L. D. Stewart, O.L.S.,D.T.S., lecturer in surveying, with Professor Galbraith as principal. These five are still members of the council, which has been enlarged to include A. P. Coleman, M.A., P.L.D., professor of assaying and metallurgy; J. A. Duff, B.A., lecturer in applied mechanics; G. R. Mickle, B.A., lecturing in mining; R. W. Angus, B.A. Sc., lecturer in mechanical engineering; A. T. Laing, B.A.Sc., demonstrator in surveying; and J. W. Bain, B.A. Sc., demonstrator in analytical chemistry. In addition six Fellows have been appointed from among the late graduates.

As early as 1888 the necessity of providing increased accommodation was recognized by the Government, and an appropriation made for the erection of a large addition to the building. This addition was completed in 1891, the equipment and the laboratory plant installed being of the best then procurable. The building as now occupied represents a floor space of nearly 60,000 square feet, but, notwithstanding, the accommodation is overtaxed, and the work of the teachers made laborious by the necessity of repeating lectures and laboratory experiments three or four times in order that all the students may receive the instruction. It has also been found necessary, from the same cause, to abandon certain experimental and research work.

That the School of Practical Science is meeting the demands of the people is clearly demonstrated by the almost constant growth in attendance. The present year is the largest yet on record, the attendance being about 220. Of these 105 are taking the mechanical and electrical course, 57 the civil engineering course, and 55 the mining course. In each of these depatrments the faculty and equipment of the school are such as to guarantee the student a thorough training in the scientific principles underlying the practice in the different professions. The splendid equipment in the electrical laboratory has already been described in these columns, while the facilities for the study of mining are equally efficient. The mining course as distinct from that of civil engineering was first established in the session of 1892-93.

It is interesting to learn that the graduates of the School of Practical Science are finding employment in connection with the development of the natural resources of the country, and that many of them are now occupying responsible positions. A glance at the calendar shows that of the 263 living graduates of the school, about 75 per cent. are employed in Canada, while the remaining 25 per cent. are scattered over other parts of the world.

PROFESSOR GALBRAITH.

The head of this admirable institution, Professor John Galbraith, is a son of the late Thomas Galbraith, of Port Hope, well known to every Scotchman in Canada as the Canadian agent of the "Scottish American." He was born in Montreal on September 5th, 1846, and educated at the Port Hope Grammar School and Toronto University. At the latter he took several scholarships in mathematics and general proficiency, and graduated in 1868 with the degree of B.A., securing the gold medal in mathematics and the Prince of Wales' prize for general proficiency. In 1875 he was granted the degree of M.A. He studied engineering and surveying under Mr. George A. Stewart, chief engineer of the Midland Railway, and was admitted as a Provincial Land Surveyor. He was employed for some ten years in railway construction work on the Intercolonial Railway, the Midland Railway, location of the Georgian Bay branch road, and exploratory surveys for the C.P.R. He was also employed for some time in the Portland Co.'s locomotive shops at Portland, Maine, U. S., and did consulting work in hydraulic engineering, receiving the appointment to the chair of engineering in the School of Science in the fall of 1878.

Professor Galbraith was one of the founders of the Canadian Society of Civil Engineers, serving for five years on the council of that body. He is also an associate member of the institute of Civil Engineers of London, England.

As principal of the School of Science, Professor Galbraith has labored zealously in its interests, and to him is due much of the credit for the high degree of efficiency which has been attained. At the outset he had an object in view. This was to fit the student for active professional work by giving him a thorough training in scientific principles rather than by attempting to give him a so-called practical training. It is along this line that the efforts of the school have been concentrated, and the wisdom of such a policy seems to be borne out by the results. If one were to enquire from any of his co-workers as to the secret of Professor Galbraith's success, the reply would probably be that it was due to his great qualifications in the direction of organizing the work at the school. As remarked by an intimate acquaintance, "he is a wonderful organizer."

After having completed his 21st year as head of the school, the proposed banquet to be tendered him is a fitting tribute of respect.

QUESTIONS AND ANSWERS

A subscriber enquires as to what amount of power can be generated by the Westinghouse generators recently installed on the Canadian side of Niagara Falls.

"Mill Owner" writes: Where water power is not obtainable, and where coal can be bought for $1.80 a ton, could electricity be generated and electrically applied by motors to the extent of 500 h.p. as cheaply as by belting and shafts, where said power would be used within a radius of 100 feet of engine shaft.

ANS.—Broadly speaking, the original or capital outlay to cover the cost of the dynamos to convert the mechanical power of the engines into electrical power, the necessary wire to carry that power to the various motors, and the motors to convert it back to its original mechanical shape, will cost considerably more than the belting and shafting necessary for the same work, though in the absence of the detail of the proposed lay-out, it is impossible to give even approximate figures. The relative cost of operating the two systems will also depend entirely on the details of the particular installation in question, though it is likely to be somewhat in favor of the electric plant, the more so as the average load drops below the full load or rated output of the whole installation. The relative advantage of the two systems, outside of the question of cost, are in every way in favor of the electric, it having the superiority in (1) simplicity and freedom from noise and dirt in the transmitting device (the wires), (2) its great flexibility, (3) facility for future extensions, with but very little change and modifications in the already existing plant, (4) the ability to furnish light as well as power, with a maximum of convenience at a minimum of cost.

"Reader" asks: Why is that a person when receiving an electric shock is unable sometimes to let go of the object grasped.

ANS.—The muscles of the hands are divided into two sets, called extensor and contractile, the former being used to open the hand when the fingers are called on to release their hold, the latter having control over the grasping or clutching powers of the hand and fingers. Obviously, as the latter action requires the exercise of very much more power than the former, the muscles controlling it are proportionately stronger than those of the latter. Now, the action of a current on the muscular system is to excite it to a state of great activity and to deprive it of its ordinary controlling power, the mind; consequently, when the muscles are agitated and left, as it were, to their own devices, the stronger set overcomes the weaker, the result being that the hands remain clenched.

"J. H.," Rossland, B.C., writes: I was told by an agent who was here the other day, that the live wire for a two-phase 3-wire system would cost me less than for a three-phase system; is he right?

ANS. We presume that the length of line, the voltages and the load are to be the same in each case, which, if so, would make his contention wrong, for the following reason. If you connect a two-phase machine, whose voltage across the terminals of each phase is say 2,000, to three line wires, you will get 2,000 volts between the common or neutral wire and either of the other two, but between these two latter you will get about 2,830 volts. On the other hand, there will be but 2,000 volts across any of the 3 line wires connected to the terminals of a 2,000 volt three-phaser. Such a two-phase system, if run with 2,830 volts across the two outsides, it is quite true, will take about 2 per cent. less copper than the three-phase machine with a minimum voltage of 2,000, but if the voltage of the former be reduced until its maximum line voltage is the same as the other, namely, 2,000 volts, it will require about twice as much copper as the three-phase machine, the length of the line and the load being the same in each case.

"Engineer" says: I want to put in a pump to supply fifty thousand gallons per day to our factory system for use in the various parts of the shop, and propose to pipe the discharge from the pump into a tank 96 feet from the ground, about how much horse-power will it take to drive the pump?

ANS.—We suppose that you intend to deliver the above 50,000 gallons in an ordinary working day of 10 hours, and also that you refer to the standard Imperial or English gallon, not the U. S., the former weighing 10 lbs. per gallon, the latter about 8⅓. If we are correct in our supposition, the following is the easiest way to get the horse-power necessary: Since a h.p. is equivalent to 33,000 lbs. raised one foot in one minute, which is usually expressed as 33,000 foot pound minutes, the problem consists in finding how many foot pound minutes there are consumed in doing the work described, which is given by the following: 50,000 gallons per 10 hours = 5,000 gallons per hour = 83⅓ gallons per minute; 83⅓ gallons at 10 lbs. per gallon weigh 833⅓ lbs., which raised through 96 feet will represent 80,000 foot pound minutes; this divided by 33,000, which as explained above are the number of foot pound minutes in a horse power, will give the h.p. required, which is slightly over 2 4/10; but it must be remembered that this is the delivered output of the pump, which, including mechanical and water frictions, is of above 60% efficiency, so to get the actual horse-power consumption required, 40% should be added to the above figure, giving a final result of 3 39/100 h.p.

MR. Donald McIntyre, who owns a water power about three miles north of Paisley, Ont., has found it necessary to increase his electric lighting plant. He has ordered from the Royal Electric Company one of their 60 h. p. S.K.C. two-phase alternating current generators, and has added a third wire to his lines from the water power to the town, thus putting him in a position to furnish power as well as light.

THE ELECTRIC STORAGE BATTERY AND ITS COMMERCIAL APPLICATION*.

By C. E. Brown

The advent of the storage battery accumulator, or secondary battery, as it is variously called, into the field of electrical engineering is of comparative recent date. This is more especially true on this side of the Atlantic than in European countries, where its use had preceeded by several years its general application on this side.

But a few years ago, perhaps five or six, it was necessary to point to European practice for all examples of successful accumulator application on a large scale and along advanced lines. This is no longer the case, as American storage battery practice is as far advanced as in any part of the world, and the American storage battery has no superior. The largest installations, too, are to be found in American cities. Its growth in importance in these few years is little short of phenomenal, and it is still rapidly increasing. The majority of the very large central stations, such as those of the Edison illuminating companies of the larger cities and the large street railway companies, depend very largely upon it, and its adoption is coming to be quite general in medium and smaller sized stations.

The history of the storage battery is practically included in the last 30 years, though the phenomena on which it is based was observed as far back as 1801. In that year Gautherot found that after decomposing water with a volta's cell, if the platinum or silver electrodes were connected together, a secondary current would flow for a brief time. The history of the storage battery from this time until the time of Plante includes the names of Volta, Davy, Schoenbein, Grove, Wheatstone, Siemens, Faraday, and others, but no practical results seem to have followed. In 1860 Gaston Plante constructed the first practical storage cell from two sheets of lead 60 cms. long by 20 cms. broad by 1 mm thick (25"x 8"x 1/25") coiled into cylindrical form, the two plates being separated by felt and the whole immersed in dilute sulphuric acid. Plante continued his researches up to 1879, which practically determined the state of the art. In 1879 Metzger applied the active material mechanically, and in 1881 Faure obtained important patents on mechanical application and shortening of the forming process. The history from this time has been in connection with its applications to practical use.

"The storage battery," according to Houston, "consists of two inert plates of metal or metallic compounds immersed in an electrolyte which is incapable of acting upon them considerably until a current has been passed from one plate to the other. On the passage of a current through the electrolyte its decomposition is effected and the electro positive or electro negative radicals are deposited on the plates, so that on the cessation of the charging current there remains a voltaic cell capable of generating an electric current."

The commercial storage battery of to-day consists of plates or frames of lead or an alloy of lead, with oxides of lead formed on, or pasted on the surface or in grooves or pockets of the plate, three or more plates being assembled together and immersed in an electrolyte of dilute sulphuric acid. The alternate plates are connected together for one electrode and the intermediate ones for the other. The metallic plate or frame of lead or an alloy of lead form the framework or support of the electrode and serves as a means of conducting the current to and from the active material. The oxides or other compounds on the surface or in the pockets or grooves are the active material, and together with the electrolyte are the seat of chemical actions which result in the formation of compounds which in the charged state are of relatively high energy of formation and in the discharged state relatively low, so that in passing from the former to the latter energy is given out, and passing from the latter to the former energy is absorbed. This amount of energy given out or absorbed is practically equal to to the electrical energy of discharge or charge. The sulphuric acid is the active part of the electrolyte, the water acting principally as a solvent used to give more favorable conditions for the action of the sulphuric acid. The plates are usually separated by perforated sheets of hard rubber or celluloid or glass rods, and all plates bound together with rubber bands. The containing vessel may be of glass or hard rubber or of lead lined wooden boxes. The number of plates varies from three to nearly one hundred in the largest batteries installed, with a corresponding variation in capacity from a fraction of one ampere to 10,000 or 12,000 amperes, the current depending both on the number and size of the plates. The voltage, on the contrary, depends on the number of cells, being approximately two volts per cell for commercial batteries.

The form and construction of plates differ very greatly. The first Plante cells were made up of thin sheets of lead with an insulating material between them. Plante found that these plates to give much capacity must be made porous on their surface. To accomplish this result he changed his cells, first putting in the current in one direction, then discharged them, reversed connections, and again charged with the current in the opposite direction. Thus the plate that was made positive on one charge was made negative on the next succeeding charge, and this process was repeated a large number of times. This he called forming the battery, and it required no less than thirty reversals to bring it up to its full capacity. After his plates were well formed he found that they soon became rotten, owing no doubt to the thinness of the plate, the chemical actions having penetrated completely through. The capacity of these cells per pound of plate was large, and has not been exceeded by the same class of battery to-day.

In 1879 Metzger did away with the tedious and expensive forming process by making boxes of perforated lead, which he filled with a mixture of lead oxide, sulphuric acid and potassium silicate for his active material. One box so formed he used for his positive plate and another for his negative. This cell was formed in two or three days, a great improvement over the very long period by the old Plante process.

Faure, working independently and at about the same time, developed this class of plate in which the substance to become the active material is mechanically applied, and which has since come to be known by his name. He applied lead oxide in the form of a paste to the surface of lead plates such as had been previously used by Plante. The positive and negative plates were separated by felt and dilute sulphuric acid used as an electrolyte.

These two types of plate, the Plante and the Faure, are the prototype of all commercial storage battery plates in use to-day, and practice is about evenly divided between them. In general, European practice inclines toward the use of the Faure type, while American practice favors the Plante. The Faure type gives a comparatively large output per pound of plate, but is best suited for moderate rates of discharge covering a considerable period of time, whereas the Plante gives a smaller output per pound, but is capable of working at very high rates of discharge.

The thin, flat plates used in the early Plante cells have been subjected to numerous modifications devised for getting a greater surface with heavier and more rigid plates, for securing better adhesion of the active material when found, and obtaining greater durability, etc. A few descriptions of typical plates will serve to illustrate the direction of these improvements. No pretense of completeness is made in these lists; that would take a far longer paper than this is designed to be, neither is it claimed that the plates described are necessarily the best of their type. It is thought, however, that they are typical of good storage battery practice to-day.

The Epstein plate is cast with deep grooves on each side, thus combining with a rigid and durable plate a large amount of surface on which the active material is formed.

The Willard plate is made from pure rolled lead and has grooves cut in each side at an angle with the horizontal, forming troughs for holding the active material. It is claimed that the plate can be bent up into almost any shape without dislodging the active material. The thin layer of active material and the large amount of surface allows of rapid discharge with danger of buckling. Each positive plate is enclosed in a perforated hard rubber envelope to avoid contact between plates.

The Ohio storage battery is made of pure rolled lead sheets. Circular grooves 1 inch in diameter and $\frac{3}{16}$ inches deep and $\frac{1}{16}$ in. thick are raised by rolling in a machine. The different circular grooves are separated by $\frac{1}{4}$ inch to avoid any tendency towards buckling.

The Rooney plate is made up of alternate corrugated and straight strips of thin rolled sheet lead placed on edge and burned into a conducting strip or rib of the lead frame at each end. This forms a very open plate with a large amount of surface.

Porous plates have been made by casting lead with powdered coke, or with pumice stone, by the formation of sulphide, the sulphur afterwards being taken out, and notably by the use of chloride of lead and zinc. The object in making these porous or partially porous plates, is to obtain a large amount of surface of the lead plate on which the active material may be found in minute quantities. The great amount of surface with the corresponding large amount of active material insures large capacity, while the minute subdivision of the active material permits of rapid discharge.

In the chloride battery the substance which is to become the basis of the active material is chloride of lead mixed with a certain proportion of chloride of zinc, and cast in small pastelles. These pastelles are then placed in a mould and a frame of an alloy of lead and antimony cast around them under great pressure. The antimony gives strength and hardness to the grid, and it is claimed is not acted on by the acid, thus avoiding local action. The grids are then packed between zinc plates in a tank containing a dilute solution of zinc chloride, and short circuited. This removes most of the chloride from the plate, the last traces being removed by thorough washing, leaving a pure spongy lead. This process was formerly used for both plates, but is now used only on the negative. The positive plate is obtained by casting the lead antimony grid under pressure, $\frac{1}{16}$ in. thick, and with holes $\frac{1}{4}$ in. in diameter. A corrugated ribbon of soft pure lead is rolled up into a spiral and pushed into these holes. The active material is formed electro-chemically from this ribbon, and causes it to expand and fill the hole tightly, making good electrical contact with the plate.

The method of formation of all these plates is quite different than that followed with the early Plante cells. The method is different with almost every manufacturer, but the object aimed at is similar in each case, namely, to form the cell quickly and avoid the tedious and expensive method of numerous charges, discharges and reversals, and at the same time procure a hard and durable plate. The plates are usually pickled in a bath of dilute nitric or acetic acid, or in some alkaline solution capable of acting on the lead until the action has penetrated to a sufficient depth, after which the coating produced is reduced to a spongy lead, or changed to lead oxide. The plate is then formed in the usual manner by charging. The cell never attains to its full capacity on the first charge, but will increase with successive chargings for quite a period of time.

The Faure, or pasted type of plate, has likewise been subjected to numerous modifications. Metzger used a perforated lead box filled with the active material; Faure spread his active material on the surface of a lead plate. The difficulties of the first

*Paper read before the Peterborough Engineering Club by C. E. Brown, of the Canadian General Electric Company were principally the great expansion due to so large a body of active material, the necessarily slow rate of discharge since the tendency of the action is from the surface inward, the poor electrical contact, etc. The difficulties of the second were principally due to the insufficient adhesion of the active material and the consequent poor electrical contact, danger of short circuits from falling of active material, and the rapid deterioration. These difficulties have been largely overcome by sub-dividing the active material and placing it in small pockets or grooves in the surface of the plate, or in holes extending through the plate. The pockets or holes are usually made smaller at the surface than in the interior, so as to wedge the active material in place, or in the case of grooves, they are made narrow, so that the plate will have a good grip upon the active material.

One of the most fruitful sources of trouble with storage batteries has been the tendency of the plate to buckle or bend out of shape with operation. This has been very largely overcome in the better modern batteries, and is no longer a source of serious trouble. The active material of the positive plate expands during discharge, and as the action on the material is never uniform, some portions will expand more than others, and tend to throw the plate out of shape, and the more rapid the discharge the greater will be the tendency. The remedy is largely in subdivision of the active material and allowing opportunity to expand in one direction. A brief description of a battery which has achieved considerable success on the continent of Europe, the Tudor battery, will serve to illustrate this class of plate.

The plates are made from pure rolled lead about ⅜ in. thick, and are grooved on both sides, the grooves being about ⅛ in. wide and a little greater in depth. These plates are first slightly peroxidized by electrolysis, forming PbO_2, and then the grooves are packed with oxides of lead, after which the plate is rolled to keep the active material in place. As the active material crumbles away, due to continued use, the action penetrates deeper into the metallic lead of the plate and keeps up the supply of active material, so that the full capacity of the plate will be maintained, even though the active material at first pasted into the grooves should entirely fa'l away.

The numerous small sections of the active material insures a large surface and permits of a high rate of discharge. The smallness of the section of active material prevents excessive swelling and consequent buckling of the plate. The method of formation gives unusually good electrical contact between the active material and the frame. Perforated sheets of hard rubber are inserted between the plates in this as in most batteries.

Numerous attempts have been made to reduce the weight of the battery by increasing the proportionate weight of active material. Among these are the use of porous earthenware containing plates to support the active material and press it against a thin sheet of lead, which serves to carry away the current, an earthenware plate being placed on each side of the lead sheet to form one plate and all plates firmly bound together with rubber bands. Wool felt has been used in strips to form pockets on each side of a sheet of lead, and the pockets filled with the active material, which is kept in place by a light sheet of perforated or porous insulating material, the various plates being bound tightly together. Perforated cells, or envelopes of celluloid filled with active material, are used for electrodes, the current being taken out by lead wires or strips passing down the center of the cell or envelope. So far as I know, none of these batteries have proved a real commercial success, except for traction purposes, where lightness is so important a consideration that some other considerations will be sacrificed to obtain it. One serious difficulty with this class of cell is the rather poor electrical contact between the active material and the lead plate, which lends itself to the formation of the insoluable lead sulphate on the surface of the lead, limiting further action by its insulating properties. The electrolyte for the lead storage battery is always dilute sulphuric acid. The proportion of acid to water is usually determined by the specific gravity of the combination and is used from 1.2 to 1.3.

In pasted or Faure type of plates red lead minium (Pb_3O_4) is generally used on the positive plate, and litharge (PbO) on the negative plate. Combinations of these oxides or other compounds are sometimes used. In some later batteries a mixture of lead sulphate and lead oxide is used. Lead is not the only metal that has been used in storage batteries, copper and zinc both having been used, but, as these batteries have never achieved any marked success commercially, they will not be discussed here.

The chemical theory of the storage battery is still, to a large extent, in the speculative stage. To the outsider it would seem an easy task to analyze the various elements entering into the action before and after charge and discharge, and determine the actual reactions that take place. When, however, the chemist approaches the task it is found to be one of extreme difficulty, so difficult that after 15 or 20 years of research and persistent effort to solve the problem, it is still, to a large extent, shrouded in mystery as to the real nature of the reactions that take place. The difficulties were expressed by Dr. Frankland in the following words: "The physical qualities of the cells are capable of very accurate estimate and investigation, but, when you come to attempt to ascertain the chemical charges that occur in charging and discharging of a storage cell, you encounter formidable difficulties. The outsider has no idea of these difficulties. Nothing seems more simple than to determine the chemical changes that take place in either the positive or the negative plate of a storage battery. It is not so in reality. The substances used as active materials are in the first place mixtures, and the mater ials obtained at the end of the reactions are also mixtures, and these mixtures are insoluable in any reagent which does not decompose them. They cannot be volatilized, they cannot be subjected to any process of solution and crystallization in order to separate and purify their elements." This will give you something of an idea of the difficulties in the way of an exact determination of the nature of the actions taking place.

The earlier ideas of the action of the storage battery were somewhat vague, and it was spoken of by no less an authority than Maxwell as storing up a quantity of energy in a manner somewhat analagous to the ordinary condenser. The first definite chemical theory was what is known as the occluded gas theory, namely, that the active material of the electrolyte is the water, and that this is decomposed in charging into its two components, oxygen and hydrogen gas, the oxygen being liberated at the positive and the hydrogen at the negative electrode where they are occluded by the electrode. The discharge would be the reverse action, the two gases reuniting in the formation of water. In this theory the sulphuric acid serves only the purpose of increasing the conductivity of the electrolyte. This theory is disproved by the fact that it only requires about 1.5 volts to electrolyze water between platinum electrodes, and therefore only 1.5 volts could be obtained by the reunion of its constituents in discharge, whereas the actual voltage of the storage battery is about two volts during the greater part of the discharge. It would be necessary to presuppose some other action than mere occlusion at the electrodes to account for this extra voltage. It was also observed that action did take place on the electrodes, the negative being reduced to metallic lead and the positive peroxidized during charge. These effects were attributed to local or waste actions. This theory is, I believe, still accepted by some authorities. It is, however, now generally discredited.

About 1882 the double sulphating theory was advanced, and this theory, with modifications and additions, despite considerable opposition, is the one generally accepted to-day. According to this theory, sulphate of lead (P_bSO_4) is formed on both electrodes during discharge, accompanied by the withdrawal of sulphuric acid (H_2SO_4) from the electrolyte and its replacement by water, H_2O. In charging the sulphate on the negative electrode is reduced to spongy metallic lead, and on the positive to peroxide of lead (P_bO_2) with the formation of sulphuric acid and the withdrawal of water from the electrolyte. These reactions, beginning with the charged condition, may be represented by the following equations :

For the positive plate : $P_bO_2 + H_2SO_4 = P_bSO_4 + H_2O + O$.

For the negative plate : $P_b + O + H_2SO_4 = P_bSO_4 + H_2O$.

Combining these negatives we have . $P_bO_2 + 2H_2SO_4 + P_b = P_bSO_4 + 2H_2O + P_bSO_4$ for the entire cell.

It is quite certain, however, that the action is not as simple as represented in these equations, but they seem to represent the net result of the normal action of the battery. It should be remembered that these equations do not represent the entire material of the cell, but only those parts actually entering into chemical reactions. This includes only a small percentage of the electrolyte and by no means all of the active materials. The action is, fortunately, and it might also be said unfortunately, a self limiting process ; unfortunately, because it limits the output of the cell to only a portion of the active material, and fortunately, because if the active material were once entirely converted to lead sulphate it would become non-conducting and non-electrolizable, and it would be impossible to reverse the cell and again charge it. When the peroxide is reduced to about 31 per cent. of the original amount on the positive plate, action will cease entirely. The voltage begins to drop so as to make further discharge undesirable considerably earlier.

The charging process is substantially the reverse of this, but there seems to be some slight difference or extra action, as, after making all allowance for resistance drop, the charging voltage is somewhat higher than that of discharge, and the sudden rise of voltage as the cell becomes charged and sudden fall at the end of discharge would seem to indicate some further irregular actions.

The attempt has been made to explain all these variations of voltage as due to variation in the density of the sulphuric acid within the substance of the active material. It is well known that the voltage of the cell increases in some degree with the increase in density of the electrolyte. Then, as sulphuric acid is formed during charge and withdrawn during discharge, it is evident that the density of the electrolyte is greater or less within the active material of the electrode direct, as the lack of porosity prevents complete diffusion of the electrolyte. The sudden rise in voltage at the end of charge and the sudden fall at the end of discharge might be explained by the decrease in porosity of the active material at these stages, causing greatly increased density of the electrolyte in one case and greatly decreased density in the other. Whether this explanation is sufficient to account for all variations in the voltage is not entirely clear.

Another, and perhaps more plausable theory to account for the rise in voltage at the end of charge, is the formation of persulphuric acid $H_2(SO_4)_2$. This is supposed to be brought about by the sulphion (SO_4) combining with the sulphuric acid in the absence of more available lead to unite with. This combination is very unstable and almost immediately breaks up, with the following result :

$H_2(SO_4)_2 + 2H_2O = 2H_2SO_4 + H_2O_2$.

$H_2O_2 = H_2O + O$.

This not only accounts for the rise in voltage, but also for the abundance of oxygen passing off when the cell becomes fully charged. The double sulphation theory is supported by the following facts . The thermo chemical equivalents of the combinations claimed would just account for the voltage observed on discharge , the increase in density of electrolyte during charge and decrease during discharge, which are well known phenomena, and the formation of lead sulphate during healthy operation.

which seems to be unquestioned. These are the more important points in support of this theory, which seems to have no formidable rival at the present time.

The efficiency of the storage battery as obtained by laboratory tests under favorable circumstances is about 80 to 85 per cent. It is doubted if it often exceeds 70 to 75 per cent. under actual commercial conditions. This difference is due to leakage, to local action, to the cells not being kept in the best conditions, and to several other causes not occurring in laboratory tests. The losses occurring in normal action are divided by Crosby and Bell as follows: 1st, the direct losses due to heating; 2nd, the losses due to local action between the supporting grid and the active material; 3rd, the losses due to local action in the active material itself, 4th, the losses due to unreversed chemical action. The first is the C^2R loss and has been reduced to quite a moderate figure in modern cells. The second is not a very serious loss in well designed cells except in cases where cells are required to stand for quite a period of time partly discharged. The third and fourth are usually the most formidable losses. The third can be reduced to some extent by subdivision of the active material, but apparently can not be eliminated. It is due largely to unequal action in the active material, and the most rigid uniformity in manufacture will not prevent this. The fourth is partly due to the formation of irreversible chemical compounds and partly to those electrolytic actions which produce free hydrogen, oxygen, ozone, etc. There seems to be no method of effectually limiting these losses. Omitting the C^2R loss, these wasteful losses have been found in some tests to be as high as 17 per cent. of the entire energy put into the cell in charging.

The theoretical value of lead peroxide has been calculated at 4.48 grammes per ampere hour, or approximately 100 ampere hours per pound. Assuming the weight of spongy lead on the negative plate to be equal to the weight of peroxide on the positive, this would give 50 ampere hours per pound of active material. Plates of the highest capacity yet manufactured do not, however, give more than 16 ampere hours per pound of active material, and as the active material forms but from 20 to 50 per cent. of the weight of the plate, the ampere hours per pound of plate will be about three to seven or eight in the best commercial cells. These figures are comparable to the efficiency of the steam engine calculated from the heating value of the coal. They suggest the great possibility of improvement, but as in the case of the steam engine, there are natural laws which prevent the complete utilization of this energy.

The Electric Storage Battery Company names the following useful applications of the storage battery: Central station lighting; central station power; trolley regulations; isolated lighting; street car traction; electric locomotives; electric launches; electric carriages; electric elevators; train lighting; telegraph and telephone, and many others which I will not mention here. Some of these applications will be discussed somewhat in detail, but before taking up these applications it may be well to state some of the general considerations which make the application of the storage battery desirable or undesirable. The storage battery is not a prime mover. It must receive its energy from some other source, store it up, and give it out again as required. It is, therefore, as regards economy, suitable for those uses only in which it can receive its energy at some time or place where energy can be had more cheaply than at the time or place that it is required to be used. For example, in the central station power can be produced generally far cheaper at the hours of minimum load than at maximum, and this is just as true for the momentary fluctuation as for the all day load curve. For these reasons the storage battery is not well adapted to service where steady continuous loads are required, except in cases where the energy is small or as reserve of great reliability. This class of service is better served directly from the prime mover. The use of a steam engine during four hours of the day to charge a storage battery which is to furnish light and power for the remaining 20 hours is not often an economical operation, however convenient it may be. On the other hand, the storage battery is well suited to loads having sudden fluctuations or of short durations. A single case will illustrate this. The battery installed by the Chicago Edison Company is rated at 22,400 ampere hours for an eight hour discharge, or at the rate of 2,800 amperes. It is quite safe to say that generating machinery rated at 2,800 amperes, including boilers, engines, feed pumps, dynamos, etc., could be installed for less money than this battery cost. But whereas the generating machinery might safely carry 4000 amperes for one hour, probably not more, the battery is guaranteed to deliver 11,000 amperes for one hour, a ratio of 2¾ to 1 in favor of the battery, and far more than enough to overcome the difference in first cost; and the battery actually does deliver considerable more than its guaranteed rate, reaching 14,000 to 15,000 amperes for short periods.

The uses to which a battery can be applied with advantage have been stated as follows: 1st, to carry the peak of the load at maximum hours; 2nd, to carry the entire load at minimum hours; 3rd, to act as equalizer or reservoir; 4th, for the equipment of annex stations. The first of these uses is the one which is generally of the most importance in illuminating stations, though the fourth is of considerable importance in many cases. The first, third and fourth are of about equal importance in railway work. The second is not much used on this side of the Atlantic in connection with steam plants.

Coming back to particular applications, we will endeavor to point out some of the ways in which the storage battery has made, or is making, itself useful. One of the applications in which it has met with undoubted success, but of which we hear little, is in connection with telegraphy. With great conservatism the telegraph companies clung to the primary battery long after it had been superceded by the generator in almost every other commercial application. The generator is not, however, well adapted to this class of work directly, except in very large equipments where the amount of energy consumed is quite large and the extra cost of complete reserve equipment is not prohibitive. It becomes, then, a question largely between the relative merits of the primary and the secondary battery, and a fair trial is all that is required to establish the great superiority of the latter in practically all cases where charging current is available. Its advantages over the primary batt ry may be stated briefly as follows: Its first cost is 75 or 80 per cent. of that of the same capacity of primary batteries; its maintenance, including cost of current for charging, 10 per cent. It should be added that this is the important item, as the maintenance cost of primary batteries per year is from two to three times the first cost, floor space from 15 to 25 per cent., and far more satisfactory operation. It would seem that the storage battery has before it a great field for expansion in connection with the telegraph; and what has been said with regard to the telegraph is in a large measure equally true for the telephone, for fire alarm systems, and other similar classes of work.

The electric lighting of railway trains from the storage battery, or with storage battery auxiliary, offers the most satisfactory solution of the difficult problem of train lighting yet presented, but has not always proven the most economical. The method of application follows two lines. Where the run is short or of moderate length, say from 5 to 12 to 15 hours, a battery of sufficient size to carry the load of the train for one trip is installed on one car, or more often it is sub-divided and a battery placed on each car. This battery is then charged in the train yards at each end of the run, or removed and a fresh battery put in place. For long runs of many hours, or perhaps days, this method cannot be used except by establishing stations along the line for recharging batteries which are exchanged at these points. For this class of service a generator may be installed on the train and the lighting current obtained directly from it, the storage battery acting as a reserve to take the load when the locomotive is uncoupled, or at all stops and times of slow speed, if the generator is run from the car axle. For the man who reads his newspaper on the train, the better distribution of light by numerous electric lights will fill a long felt want, and the user of the sleeping car, after a brief experience with it, will wonder how he ever got along without the berth light. One of the best illustrations of train lighting is in the case of the Chicago, Burlington & Quincy Railway, between Chicago and Minneapolis. These trains have been lighted by storage batteries for about three years, and they have given perfect satisfaction. The trains referred to are said to be the finest in the world. Each car is equipped with a battery, the batteries all running in parallel. They are charged while the train stands at the station at each end of each run, and no time is lost by the operation. The trains make one trip daily, which occupies 14 hours. The cars are equipped with from 25 to 75 lights, each according to the nature of the car, and each berth in the sleeper has its frosted globe lamp. The expense of lighting this train has been a little greater than it would have been with oil or gas, but the travelling public once having become accustomed to this quality of lighting will not readily put up with anything inferior.

In the larger field of storage battery auxiliaries to central stations, both light, power and railway, we will find that the determining question in the installation of such batteries is, does it pay—will the investment in storage battery yield a larger dividend, or will it cost the station as a whole to yield larger dividends than the same investment in generating machinery? and this question must be answered for each individual station. The use of a battery as a reserve in case of a necessary shut down, or as a means of steadying the buss bar voltage, is important, but batteries are seldom installed principally for this purpose, they are installed to earn dividends. From the largely increased number of plants installed in the last few years, since the system has been fairly tested, it would seem that they have succeeded in earning dividends in a large number of cases. After the installation of the first battery by the Boston Edison Company, Mr. C. S. Edgar, of that company, stated the case which confronted them and the results obtained somewhat as follows: The peak of their load represented 50 per cent. of the total load at the time of maximum, but only 10 per cent. of the total output for the 24 hours. It became necessary to provide some means of carrying this peak of the load owing to increasing output. If a steam plant were installed to carry this 10 per cent. of the output, it would require a plant of equal capacity with existing steam plant, the existing plant carrying the other 90 per cent. without difficulty. It was found that a steam plant of the required capacity would cost $65,000, a battery plant complete could be installed for $50,000. The battery was installed with a guarantee to be kept in good working order for 6 per cent. per annum on cost of cells. The battery improved the load factor greatly, and it became possible to run the generating machinery at a load never less than 75 per cent. of the rated full load. This, of course, reduced the operating expenses and brought up the efficiency of the steam plant. It has been found by careful records that the losses in the battery are offset more than four fold by the reduced losses in the generating machinery, because of the higher efficiency of operation with the higher load factor. The results, then, in this particular case, show lower first cost, lower operating expenses, and a depreciation at least as low as could have been obtained with an equivalent steam plant. This appears to be fairly typical of the results to be obtained in most illuminating stations of large or moderately large capacity. The load curve in these stations has a peak of short duration which is quite a large percentage of the load, and which is very expensively and inefficiently carried by steam generating machinery.

It is interesting to note that the Boston Edison Company now has four batteries installed, and that their generating machinery, which is of the best multipolar type, has a rated capacity of less than 50 per cent. of the load on the station at the peak of the load curve, and carries 90 per cent. of the total output of the station directly. In railway power stations it is not alone the peaks that need looking after, but also the sudden variations or fluctuations which so often limit the output of the generator to an average far below the rated capacity. The purpose of the battery in street railway power stations is to carry the peak of the load when it comes, to charge when the load is light, and to take the fluctuations at all times, charging at one moment and discharging at the next, so that the load on the generating machinery remains nearly constant. This use is quite similar to that already described for illuminating stations, except that it is necessary to keep the battery floating on the line during the whole time it is used for equalizing the fluctuations. Another class of work quite different from this is the use of battery sub-stations on lines extending a long distance from the power station and on which the drop becomes excessive at times of heavy load. There are several methods of taking care of such cases -putting in sufficient copper in the feeder to keep the voltage up, installing separate steam plant at the location needed, the use of a booster and separate feeders for that line, or a storage battery sub-station. The first of these remedies is usually the most expensive. The second gives the highest operating expense, and the third, though often the cheapest, is necessarily of very low efficiency, often under 50 per cent. Without entering into the evidence on either side, it is sufficient to say that in many cases the battery offers the most satisfactory solution of the problem. For this class of work the battery is generally connected directly across the line without booster or other apparatus. It is calculated for a voltage equal to the voltage on the line with the average load. When the load is less the drop will be less and the battery will charge. When the load is greater the drop will be greater and the battery will discharge, thus taking nearly constant current over the feeders at all times, the conditions of maximum economy.

A rather novel case of this use of the storage battery is found in connection with the Brooklyn Heights Railway Company. On their Coney Island line the traffic is very heavy for three or four months in the summer and is practically nil at other seasons. For this service they have installed on six freight cars a large battery which is run out and connected up near the end of the line in summer time. When the season is over the battery is run back to the station or to any point on the line where it will be the most serviceable.

It is often thought that a battery is only applicable to large stations, but a little enquiry will show that very beneficial results can often be obtained in small stations. In Peekskill, N. Y., the Street Railway Company operates 4¾ miles of track, running from three to five cars. With the five car schedule the fluctuations are from zero to 310 amperes at 575 volts, or 178 k.w., yet this load is carried on a 60 k w. generator, with the assistance of a battery rated at 160 amperes for one hour, and a small differential booster operating automatically, and the load on the generator is practically constant at about full load. The curve of generator and battery load will explain more than any words. The saving in generator capacity and the increased efficiency of operation will be apparent at a glance.

Before leaving the subject of central station batteries, it may be well to sketch briefly the methods of operation in these plants. In illuminating stations the use of end cell switches is almost universal. The battery terminals for a number of the end cells (this number being as high as 30 for the Chicago Edison Company) are carried to the switch-board and connected to a set of contact bars. A moving switch or contact piece, connected to one line or busbar, travels over these terminals, thus cutting in or out cells as required to give the required voltage. This arrangement is usually operated electrically and is semi-automatic.

A switch must be closed by hand, which starts the moving contact to cut in or out cells as desired. This contact once started cuts out one cell and then stops, and cannot be stopped sooner. If this effect is not enough the switch may be closed again and so on until as many cells are cut out as desired. The object of this arrangement is to prevent the switch stopping on two contacts and thus short-circuiting a cell.

For street railway work it is necessary to have some automatic means of regulating the voltage on a battery, as the fluctuations are so sudden that no hand operated method could possibly answer the purpose. Railway generators are invariably compounded, and if the battery were connected directly across the busbars, their load would increase directly as the load on the system increased and only aggravate the trouble they are intended to overcome.

The general arrangement for this class of work is to use a differential booster. This is a generator wound with a weak shunt field and a very strong series field. The series field is connected in opposition to the short field and in series with the line. The armature is connected in series with the battery and in such direction that the voltage generated by the shunt field opposes the battery voltage and the voltage generated by the series field assists it. The adjustment is so made that when the load on the line is normal the booster voltage will be zero and the battery neither receives nor gives current. When the load on the line falls, the voltage of the booster in opposition to the battery rises on account of the shunt field overcoming the series, and forces current through the battery, charging it and keeping up the load on the generators. When the load on the line rises the voltage of the booster rises, assisting the battery voltage, due to the series field overcoming the shunt and the battery discharger relieving the generator of a part of the line load. If it is found at any time that the battery is discharging faster than it is charging, a slight turn of the shunt field rheostat will bring up the shunt field and give the battery more charge and bring a slightly larger load on the generators, or vice versa. This arrangement when once adjusted works with great satisfaction and regulates the load on the generator with great constancy.

There is one other application in connection with central stations which I wish to mention. I refer to the use of the storage battery as a substitute for the usual isolated station, in office buildings, large stores, etc. The load in these buildings is usually quite large for a short time and relatively small during the remainder of the day. The time of maximum load coincides with the peak of the central station load, so that they are unprofitable customers when served in the usual way, hence the isolated stations are so generally installed. By the use of storage batteries these buildings may be cut off from the station entirely during the hours of its maximum load, the storage battery carrying the entire load of the building. During the remainder of the day the battery may float on the lines, acting as a regulator for the elevators and charging when the station load is a minimum. In one particular case the illuminating company was ready to furnish power for this method at 4½ cents per k.w. hour, when their price for the usual method was 13 cents. The cost of battery will not differ much from the cost of a steam plant with direct connected units, and it is quite certain that the operating expenses would be less in most cases. There would seem to be an extensive field in the larger cities.

I had hoped to take up the subject of storage battery traction at some length, but owing to the lack of time and the length this paper has already assumed, I will dismiss it with a few words. Technically speaking, the storage battery street car has proved an entire success. The various difficulties that have loomed up from time to time have been satisfactorily settled, and lines have operated for months giving as good service as could be asked. But the proof of the pudding is in the eating, and as these roads have generally been abandoned after a period of successful operation, there is but one conclusion, namely, they have not been a commercial success.

The automobile is not so easily disposed of. It seems to be a settled thing that there are to be automobiles, and quite a good many of them in the near future in the larger cities. Shall they be electrics or some other kind, gasoline or steam? The points in favor of the electrics are briefly about as follows: Extreme simplicity in construction and operation; entire freedom from danger of explosion or fire and from smoke, disagreeable odors, excessive oil and dirt, etc.; low operating expenses as compared with horse traction in the larger cities. The points against them in the comparison are: Great weight of battery and consequent limit of grades that can be ascended; large first cost; limit of operation to a certain radius from the charging station to which it must return for a new charge when its supply is exhausted.

These objections, though prohibitive of the general adoption of the electric automobile at the present time, are not so serious against city service as would at first appear. The electric can mount a grade of 12 per cent., and this is as steep as will often be encountered on city streets. The first cost is not greater than that of horse carriages used for city driving purposes, with a suitable driving team. With the multiplication of automobiles, charging stations will be established all over the larger cities and well out into the surrounding country, so that no difficulty will be experienced in obtaining a charge once they are in general use. In spite of the difficulties in the way, I have considerable faith in the ultimate triumph of the electric automobile in a somewhat limited field.

TRADE NOTES.

The Robb Engineering Co. are building a 250 horse power engine for shipment to Calcutta, India. The order was received through their representatives in London, Messrs. Dick, Kerr & Co.

The Central Electric Company, of Portage la Prairie, Man., have just installed and placed in operation a 150 k. w. S. K. C. two phase alternator. They contemplate going into the power business.

The War Eagle Mining Co., of Rossland, B. C., have placed their order with the Royal Electric Company for one of their two-phase 20 h. p. S. K. C. induction motors. This is one of a series of motors that will be installed by these people for small power purposes in and about their mines.

The Hutton Electric Company, of Brampton and Huttonville, who had their plant destroyed by fire last spring, and who have been operating temporarily since, have purchased from the Royal Electric Company one 1500 light alternating current generator and one 50 light arc machine. These are in use at the hydraulic power house at Huttonville.

The Atlantic Grindstone Company, of Providence, R. I., who purchased the grindstone quarry at Lower Cove, N. S., some months ago, intend equipping the quarry with modern machinery and largely increasing the output. The power will be supplied by two 125 horse power Mumford boilers and a 250 horse power Robb-Armstrong engine, which are being built by the Robb Engineering Company.

The Perth Water & Electric Co., who have been operating their water system by electrically driven pumps from their lighting station, where they have had a 150 k. w. S. K. C. generator in operation for the past two years, have found it necessary to increase their plant both for power and light, and have placed their order with the Royal Electric Company for one of their 200 k. w. S. K. C. two phase generators, which is being installed to work in parallel with their present outfit.

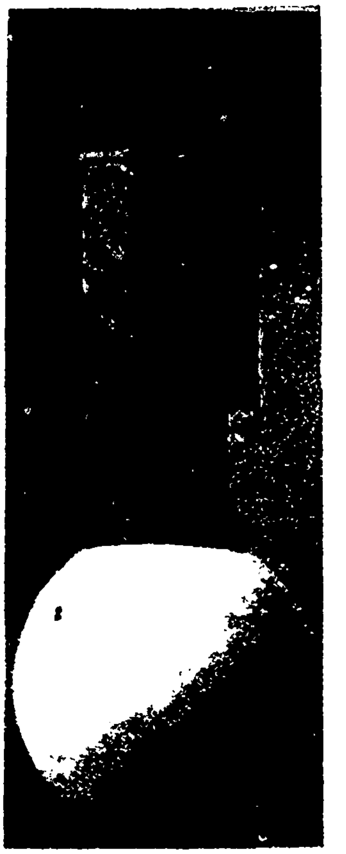
The Canadian Oak Belting Co., of Montreal, have removed their belt factory to Brockville, Ont., having purchased the tannery there formerly owned by McLaren & McCrady. This tannery is equipped with modern appliances for turning out a superior quality of oak tanned leather, especially suitable for the manufacture of leather belting. The tannery and belt factory will be under the management of Mr. J. B. McArthur, who has had twenty-eight years' experience in the business. They will continue their office at 771 Craig street, Montreal.

Messrs. Fair & Sargent, of Bancroft, Ont., are about to put in an electric light plant in that town. They have placed their order with the Royal Electric Company for two direct current generators, with a capacity of about 500 lights, also the necessary supplies. Messrs. Fair & Sargent certainly are enterprising and deserve success in their venture. They expect to have the lights in operation by Christmas.

NEW ALTERNATING ARC LAMP.

The accompanying illustration is of a new alterating arc lamp, the inventors of which are Messrs. F. W. Martin, station superintendent, and Frank Stewart, of the Hamilton Electric Light & Cataract Power Co., of Hamilton, Ont.

The lamp as shown has an octagon bonnet, nicely oxidized. The lamp is less than 30 inches long, and looks very neat and attractive. It is for ordinary use, such as for store lighting. Altogether, this lamp is designed in eight different styles, some for office or warehouse use, some for factory, and some for outdoor types, the idea being to give a range in prices in the different styles and finish. One of the features of the lamp is its long life; using a ½ inch carbon it is claimed a lamp will burn with safety between each trimming fully eighty hours. It is very easily trimmed. The trim spring holds the chamber tight to the gas check. To trim the lamp this is pulled down to release the chamber and the carbon put in, very much the same as an old style D. C. lamp. The lamp has a carbon rod which is used on account of the difficulty sometimes found by using a carbon feed. Any uneven or slightly crooked carbon will not stick. The carbon rod allows the lamp to feed more evenly.



NEW ARC LAMP.

The make of the lamp is simple, yet it is strongly constructed so as not to get out of order. The carbons are controlled by a single magnet coil, which has a sheath or iron cover. This cover both strengthens and makes it more efficient, and keeps the coil cool. Opposite the magnet there is a dash pot which allows an easy pick-up when the lamp is starting. The current is adjusted through a reactive coil, and the lambs ordinarily are adjusted to five amperes, unless otherwise ordered.

The inventors have assigned an interest in the lamp to the well known firm of Brown, Boggs & Co., of Hamilton, Ont., who already have filled several orders, and the encouraging results have warranted them in adding an additional three storey building to their factory, which is nearing completion, and they will then be in a position to meet the demand which is being experienced for these lamps.

AMALGAMATION OF ELECTRICAL INTERESTS.

Negotiations have been under way for some time looking to the absorption by the Canadian General Electric Company of the manufacturing department of the Royal Electric Company at Montreal. No official announcement has been made, but it is believed that the deal has been closed. In all probability the extensive works of the Royal Electric Company at Montreal will continue to be operated. The Royal Company will devote its attention exclusively to the light and power business, the intention being to develop the Chambly power to its full extent.

MORE LIGHT WANTED.

MONTREAL, Nov. 15, 1900.

Editor ELECTRICAL NEWS:

On page 214 of your November issue mention is made of Messrs. Strickland & Company's "Persuader. Do our good friends object to throwing a little more light on the subject?

Yours truly,

"WIREMAN."

TESTS OF LIGHTING APPARATUS.

SCHOOL OF PRACTICAL SCIENCE,
TORONTO, December 4th, 1900.

Editor ELECTRICAL NEWS:

SIR, –In your last issue, on page 207, there appear some comments on "Street Lighting in Toronto" which bear special reference to a series of tests which we have made at the School of Practical Science, for the city, on the various appliances offered under tender to the city for street lighting, and to our reports on the tests. You say truly that our task was not an easy one; and we doubt whether in a short statement it is possible to explain the points involved, but as some of the comments in the article referred to seem not to put the question quite fairly, we wish here to refer to them. The first portion of our report gave detailed information with regard to the light obtained from each of the nineteen different appliances, and its distribution in the various directions, the supplementary portion was prepared in order to meet the requirement of a comparison between the illumination of the streets and the cost of the same in the case of each illuminant; it was not intended to be considered separately. Referring to Palaz' treatise on "Industrial Photometry, with Special Application to Electric Lighting," translated by Paterson, page 294, we find the opinion given, supported also by other authority, that in the lighting of large open areas the mean illumination as well as the minimum should be taken into consideration.

In the second portion of our report we have done this, the first column, the price per candle power, giving information as to mean illumination, and the second the cost per mile lighted up to a given minimum of illumination. Compared in the latter way the results must naturally appear less favorable to all high candle-power lamps, for sub-division of light necessarily improves the minimum illumination. Also from this point of view the arc light is under the disadvantage that the ray which is effective on the roadway at the point of its least illumination (somewhere near 10 degrees below the horizontal, depending on the distance assumed between lamps) is of comparatively low intensity. On the other hand, the arc light makes an excellent showing in the first column (cost per candle), already referred to. It seems not unlikely that these figures may appear "contradictory and misleading," but the fact is that the subject is by no means simple, and there is room for considerable difference of opinion as to the proper method of valuing street illumination.

Referring to the "hydrocarbon lamp with special reflector," the article states, "It seems strange that while on the basis of cost per mile such a favorable showing is made for the hydrocarbon lamp with special reflector the cost of candle power should have been omitted in respect to this particular type of appartus only." There is, however, nothing strange about this omission; the reason this test was asked for was to determine the effectiveness of the reflector for its purpose, a matter fully described on page 11 of our first report. To determine the "cost per candle-power" the mean hemispherical candlepower would have been required. This would have necessitated several hundred more settings of the photometer and have involved much extra work, more, in fact, than time permitted. The value of the quantity, however, cannot be very different from that for the same lamp without the reflector. Again, it is stated that "it is unfair to calculate on the basis of cost per mile of illumination, particularly with the special reflector which throws most of the light in one direction, as most of the lights on the streets of Toronto are on street corners and diffuse light north, south, east and west." The lamp referred to was offered as a tender for low candle power illumination in competition with the Consumer's Gas Company. Of the gas lamps now on the streets, numbering about 960, only about one-quarter are at street corners, so that the question of the allowance for street corners in the case of these lamps is of much less importance than one would be lead to suppose from the statement quoted. The statement can perhaps fairly be used of the arc lights, of which we understand that about two-thirds are on corners; this, of course, gives them the advantage of lighting two extra spaces on cross streets by means of two out of three lamps, or altogether five spaces with three lamps, thus reducing the average cost per mile to 60 per cent. of what it would be if none were on corners. These considerations, as well as the fact that if lights are to be placed in certain definite positions in any case the total cost is proportional to the price of a single light, are so obvious that we did not consider it necessary to mention them.

Again, we find it stated that "another peculiarity of the report is that the point of illumination at which the tests were made was the minimum for the electric light and approximately the maximum for the gas light." This statement we consider to be particularly unfair to our report, implying as it does that we simply made tests at one point on the lamp, whereas the values given for each of the nine different arc light tests for the mean spherical candlepower were obtained from 66 points each, and the mean hemispherical from 50.

In the first part of the report also the values of the horizontal, the maximum candlepower, and that 10 degrees below the horizontal, are stated in each case. Further, as to the fact that the ray which strikes the ground midway between lamps (and therefore must be used in calculating the minimum illumination on the street) is but a poor specimen of the rays from an arc lamp, while it is practically of the maximum strength for a gas or mantle light, that is, as mentioned above, simply the misfortune of the arc light. Finally it is stated that "this extra and increasing light at every other point than the maximum was not taken into account at all." Now, this is exactly what was taken account of in the adjacent column, namely, "cost of candlepower," in which account was taken of all light delivered below the horizontal.

Yours truly,
W. H. ELLIS,
T. R. ROSEBRUGH.

MONTREAL

Branch office of the CANADIAN ELECTRICAL NEWS, Imperial Building.

MONTREAL, December 7th, 1900.

The late street car accident on Guy street north (Cote de Neiges Hill), caused by the trolley coming off, could have been prevented by having air brake or some similar equipment instead of hand brake, a thing absolutely necessary on long hills of this sort ; further, by preventing the public by some means or other from crowding on the back platform until the front motors are almost lifted off the ground. One thing, however, must be remembered, that the Montreal Street Railway Company were forced to build this line, by our worthy city council, against their protests. The line is only to accommodate a very few persons on all days except Sunday, when the line is better patronized by people going to the Roman Catholic cemetery. It is highly probable that this line does not pay expenses.

The elections have come and gone, and were not of especial interest to the electrical fraternity in Montreal. The only point where they are of consequence is in customs duties, and these have been badly assorted under both regimes as regards electrical merchandise in general.

We hear of the number of new cars which the Montreal Street Railway are going to give us, and of the additional horse-power purchased from the Chambly Company, but we still hang on like flies, and the old joke of "there's always room for one more" still stands good.

When we read on page 214 of your November issue about city electrician L. J. Morgan, of Kansas City, we Montrealers can sympathize with the lot of our veteran city electrician, Mr. T. H. Badger, who no doubt has as much if not more to put up with.

It may interest some of the readers of the ELECTRICAL NEWS to know that the systems of barb wire on top of poles as a protection against lightning, described on page 205, was in use between Montmorency Falls and Quebec long before the Chambly transmission was in existence. It may have differed in detail, but the principle involved was the same, and particulars as to its efficacy can no doubt be procured from Mr. Louis Burran, electrical engineer for the Quebec Light and Power Company.

Three Windsor cars, one with a white lamp, second with a red lamp, and third with a green lamp, was a soul-inspiring sight the other evening. The lamps are supposed to designate the line, but possibly the effect of the elections accounts for the red tinge. Double trucks to cars is a recent novelty here ; in fact, if this sort of thing continues we might possibly expect a seat in the cars at business hours in the near future.

One who has tried to open up business relations with firms in Great Britain states that he "gives it up." The delay is simply out of all question ; the order, be it ever so urgent, is numbered and hung on the fyle to go through in regular order, so that in spite of the preferential tariff orders go to the United States. This is not as it should be, but the fault does not lie with Canada.

One of the hardest pieces of luck was the breaking of the dam at Chambly. To add to it, the following day, when numerous temporary circuits had to be run on the poles by the Royal Company, so as to connect with the Lachine Company's sub-station, where a loan of 1,000 h.p. had been arranged for, the weather was magnificent—rain, snow and freezing following each other. Again, before all the temporary arrangements were fully complete, along came a wind storm of 70 miles per hour violence, blowing down a number of important poles, the property of the Royal Company. Although other companies with outside wires were more or less damaged by the wind, the Royal are especially entitled to sympathy under the circumstances. Their outside corps of linemen have been at it night and day, and it speaks volumes for them that steam was got promptly in the reserve station, lines connected, and incandescent and arcs running as usual practically without intermission.

It is rumored that the deal whereby the Canadian General Electric Company takes over the manufacturing department of the Royal Electric Company is "un fait accompli," and why not? The Canadian General have room and can do it, the Royal Electric want room for extending lighting station facilities, and would get it. It would seem a good move for both parties.

The Electrical Workers' Union is the latest thing out, and they assure the trade that they do not intend to countenance "strikes." What about the one in Ottawa ? or has it no connection with this union in question ? One thing is sure, and that is that although the trade in Montreal seems to be jealous of one another, if any such practice springs up they will combine for mutual protection in that direction, and the strike can have but one ending, i.e., disastrous to the employees. As the winter here makes a very dull season, even if successful in a summer strike, the malefactors could easily be weeded out when the proper time came, and the companies generally notified. The "walking delegate," (if we may assume this as his title) who loafed around the Balmoral hotel for several weeks last summer establishing this union, must have had his expenses paid out of the pockets of wiremen, etc., who could ill afford dues for such purposes. First-class wages and all round work for the year are easily procurable here by thorough, reliable and steady wiremen, but rarely do we find a combination of these three essentials. Let the union bring up the standard of the men and wages will rise without effort on their part. Some of the so called wiremen here, would not be tolerated in the United States for 24 hours.

EVENTS AT MCGILL.

The first meeting of the McGill Applied Science Society for this session was held early in November. A lecture was given by Mr. McNab, engineer of the Victoria bridge, in which he enumerated the difficulties that were encountered in building the bridge and the means that were used to overcome them. A series of advanced lectures for demonstration in the laboratories and for graduates generally has been arranged for. The first of these was given on November 13th, when Prof. Rutherford spoke on "Discharge of Electricity through Gases."

AMERICAN SCHOOL OF CORRESPONDENCE.

The American School of Correspondence, Boston, Mass., has recently added ur new instructors to its staff, all of whom are teachers at Th Massachusetts Institute of Technology. These are: William S. Newell, boilers; Joseph C. Riley, machine design; Walter S. Leland, steam engines ; and Frank R. Swift, chemistry. The Canadian interests of the school are presided over by Mr. R. R. Miller, with headquarters at Elliott House, Toronto.

SPARKS.

The construction of an electric railway between the villages of Schomberg and Lloydtown, Ont., is said to be an assured fact.

Steps are unde way looking to the introduction of the electric light in Weymou .S. Leading citizens have agreed to take 250 lights.

It is rumored that Mr. J. A. Shibley, of New York, has made an offer for the purchase of the electric street railway system of Kingston, Ont.

The city council of Toronto is desirous of corresponding with persons interested in the formation of a company to build a system of radial electric railways.

Messrs. Harden & Barber, who are at the head of the scheme to build an electric railway from Brighton to Havelock, Ont., have held meetings in several municipalities recently.

Mr. Geo. McAllister, of Bloomingdale, Ont., has purchased a small water power and intends to generate electric power to be used in connection with his saw-milling operations.

At a recent meeting of the town council of St. Marys, Ont., it was decided to engage a superintendent, electrician, and first and second engineers for the waterworks and electric light systems.

Mr. C. Beck, president of the Penetanguishene and Midland Electric Street Railway, Light & Power Company, is again considering the project of an electric railway between Midland and Penetang.

The Bell Telephone Company are extending their system from Quebec eastward. They have just opened an exchange at Fraserville, and are canvassing other towns and villages with the same object in view.

Negotiations are again said to be under way for the absorption of the Metropolitan electric railway by the Toronto Street Railway Company. Should the deal be concluded, the extension of the Metropolitan road may be looked for.

The Listowel Electric Light Company are enlarging and remodelling their power house and installing a new engine manufactured by the Goldie & McCulloch Company, of Galt. They propose suppplying power as well as light.

Mr. M. F. Beach is erecting a temporary wooden building at Iroquois, Ont., in which he will install an electric plant for operating his mill. In the spring it is his intention to erect a stone and brick power house, in which he may install a plant for lighting purposes.

The Royal Electric Company have reconsidered their decision to close down the electric light plant at Orillia, Ont., and are said to have made a verbal offer to expend $10,000 in extending the plant providing the municipality will give a franchise for a number of years.

The Central Electric Company have submitted a tender for lighting the streets of the town of Portage la Prairie, Man., for the next seven years. It has been suggested that the town inaugurate civic ownership, but it is probable that the offer of the Central Electric Company will be accepted.

Mr. J. Keith-Fisher, of the British Columbia Portland Cement Company, Vancouver, has organized a company of American capitalists to establish extensive cement works near Sydney, on Vancouver Island, in British Columbia. The works will have an ultimate capacity of 2,000 barrels a day, and will be operated by electric power.

The Brantford Electric & Operating Company, who have been operating a 180 k.w. S.K.C. machine for the past two years, have found it necessary to increase their capacity for both light and power, and have just started an additional 300 k. w. S K.C. two-phase generator furnished them by the Royal Electric Co., Montreal. This gives them a total capacity of nearly 600 k.w.

It is understood that negotiations have been practically completed for the purchase by Deane & Shibley, of New York, of the electric street railway, electric lighting, and gas franchises of the city of Bellville, Ont. The purchasers are to extend the railway, to reduce the cost of street lighting to $65 per lamp per year, to lower the price of gas 25 cents to $2 per thousand feet, and to supply 1,000 horse power for manufacturing purposes.

SPARKS.

Mayor Houston, of Nelson, B. C., is advocating the installation by the town of a municipal electric light plant.

The electric light plant at Welland, Ont., owned by Mr. C. J. Page, was totally destroyed by fire on November 26th.

Mr. G. E. Kidd speaks hopefully of the prospects for the construction of an electric railway between Brockville and Ottawa.

Mr. J. F. Webb, of Ypsilanti, Mich., is promoting a scheme for the construction of an electric railway from Windsor to Leamington.

The corporation of Preston, Ont., is considering the advisability of purchasing the electric light plant owned by Wm. S. Fenwick.

The town of Oxford, N. S., is installing a new system of electric lighting, and will do away with their old plant, which is run by water power.

The St. Thomas Street Railway Company, of St. Thomas, Ont., are considering the extension of their road to the lake and in other directions.

The Crow's Nest Pass Coal Co. has ordered a 350 horse power engine from the Robb Engineering Company for its mines at Fernie, British Columbia.

The Ingersoll Power & Electric Light Company have renewed their contract for lighting the town of Ingersoll, Ont., for a further term of five years.

The City Council and the Board of Trade of Nanaimo, B.C., are taking joint action to secure the construction of an electric railway to the Extension Mines.

The shops of the Grand Trunk railway at Point Ste. Charles, Que., will be lighted electrically, the Chambly Manufacturing Company supplying the current.

The Ontario Government is being urged to install an electric light plant in the Parliament buildings, Toronto. It is estimated that the necessary plant will cost about $15,000.

The Institute for the Blind, Brantford, are installing a two-phase K.C.S. motor for power purposes, the current being supplied by the Brantford Electric & Operating Company.

Dr. Thompson, of Cayuga, the owner of the electric lighting plant there, and whose power house was destroyed by fire some six weeks ago, is rebuilding, and has placed his order with the Royal Electric Company for a 750 light alterating current dynamo, with the accessories.

Mr. George Sleeman, of Guelph, Ont., is reported to have sold the riget to manufacture the Sleeman fender in the United States, receiving therefor a lump sum and a royalty on each fender manufactured.

The city of Victoria, B. C., recently received the folllowing tenders for an electric lighting plant at the waterworks pumping station: Marine Iron Works, $548; B. F. Sturtevant, Boston, Mass., $594; Canadian General Electric Company, Vancouver, $800, $850 and $385—three bids; Hinton Electric Company, $475.

The Marmora Electric Light Company have secured an hydraulic power from Messrs. Pearce and are installing a 1000 light alternating current generator, with S.K.C. transformers, etc., from the Royal Electric Company, Montreal. They expect to be in operation before the extreme cold weather sets in.

The Bell Telephone Company have, through the local manager at Galt, Mr. J. N. Taylor, installed a seven station warehouse system for Cowan & Co., a five station for the R. McDougall Co., and a four station for the C. Turnbull Co. The work in connection with the installation was done by Mr. McHugh R. Polson, of the company's staff in Hamilton.

The corporation of the town of Parrsboro, N. S., have taken up the municipal lighting question, and have placed their order with the Royal Electric Company for one 50 k. w. S.K.C. two-phase generator, 500 lights capacity in transformers and wiring supplies. It is expected that the plant will be in operation by the first of the new year.

The Berlin Gas Company, of Berlin, Ont., have renewed their contract for lighting the town for five years. The new contract calls for an all night service. The company recently installed a new Ball dynamo, and are using the latest type of enclosed arc lamps, which are giving good satisfaction. They have forty open and forty enclosed arc lamps.

The Edwardsburg Starch Company, of Cardinal, Ont., whose large factory was destroyed by fire about three months ago, have entirely rebuilt the premises, and are installing a complete electric light and power plant, consisting of two 50 k. w. S.K.C. generators, with switchboards, transformers and motors complete, making it one of the latest and most up-to-date plants in Canada.

The corporation of the town of Newmarket, who four years ago undertook the operation of the electric lighting plant for street as well as commercial lighting, and who at that time installed a complete up-to-date plant, consisting of slow speed condensing engines, S.K.C. generators, and Wood arc dynamo, have found it necessary in order to keep up with the demand for additional street as well as indoor lighting, to increase their plant, and have placed their order with the Goldie & McCulloch Co., of Galt, for a 250 h. p. Wheelock engine, and with the Royal Electric Co. for an additional 100 k. w. S.K.C. two-phase dynamo, with the necessary station accessories and transformers. This town, for its size, will possess one of the most modern and up-to-date plants to be found in Canada.

PERSONAL.

Mr. J. B. McGovern, of Detroit, Mich., is now in charge of the electric light plant at Mitchell, Ont.

Mr. Geo. W. Thompson has been appointed chief engineer for the T. Eaton Company, Toronto, as successor to Mr. E. J. Philip.

Mr. E. Bent, the first engineer employed in the electric light station at Digby, N. S., died recently at Bear River, where he had established an electric light plant.

Mr. J. A. Cokers, manager of the Bell Telephone Company at St. Johns, Que., has taken charge of the exchange at Cornwall, Ont., and has been succeeded at St. Johns by Mr. Gagnier.

Mr. Robert Maxwell, who has been engineer at the Toronto jail for about eighteen years, recently tendered his resignation on account of ill health. His assistant, Mr. John Brown, has been appointed to the position.

Mr. T. F. Dryden, formerly with the Royal Electric Company, has recently been appointed agent for Western Ontario for the Westinghouse Electric & Manufacturing Company, with an office at 404 Temple Building, Toronto.

Mr. R. Burrows, local manager of the Bell Telephone exchange at Orillia, Ont., has been transferred to Sault Ste Marie. Prior to leaving Orillia he was banqueted and presented with a gold headed cane and valuable rifle.

Mr. Edward J. Germain, road-master for the Toronto Railway Company, is about to leave for Birmingham, England, to accept an important position on the street railway system of that city. On Nov. 30th he was tendered a banquet at McConkey's by the different road-masters of the Toronto Railway Company. Road-master Wallace presided, and on behalf of his colleagues presented Mr. Germain with a beautiful gold locket, suitably engraved.

An electric street railway will likely be constructed from St. Albans, Que., to St. Alban's Bay.

The Hanover Electric Light & Power Company recently installed a new three-phase generator, manufactured by the Canadian General Electric Company, also a new 50 h.p. motor, in addition to the 20 h.p. motor installed a short time ago. They intend putting in a complete new arc system throughout, equipped with the latest type of enclosed arc lamps.

TORONTO and CENTRAL ONTARIO ELECTRICAL RAILWAY

TO CAPITALISTS AND PROMOTERS.

PUBLIC NOTICE

The Corporation of the City of Toronto desires to have an electric railway system constructed to run to and from the new St. Lawrence market, Toronto, for a distance of 100 miles east, west and north therefrom, said railway system to have six or more main lines, with branches, and a total mileage for the present of 500 miles.

The said Corporation of the City of Toronto will assist to obtain a special Act of the Legislature to incorporate a company under the Electric Railway Act, the Acts respecting companies to supply light, power, etc. (R. S. O., chaps. 199, 200 and 209), and with special powers.

All persons or corporations interested in the formation of such a company, or in the construction of the said railway system by the said company, may obtain full information from Alderman Daniel Lamb, Chairman of the Committee of Works, Toronto, up to the 31st day of December, 1900.

E. A. MACDONALD, Mayor.

Toronto, Canada, Nov. 22, 1900.

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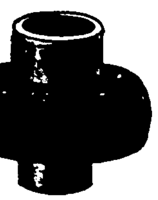

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SPARKS.

Messrs. Pratt & Latchworth, of Brantford, have placed in their new factory a 30 h. p. S.K.C. two-phase motor, which is operated from the lines of the Brantford Electric and Operating Company.

The ratepayers of Woodstock, Ont., by a considerable majority, have voted in favor of raising $30,000 for a municipal lighting plant, $14,000 to purchase the existing plant and $16,000 for extensions and improvements.

The corporation of Brigdewater, N. S., have found it necessary to increase their incandescent lighting capacity, and for this purpose have placed their order with the Royal Electric Co. for one 80 k.w. S.K.C. generator, with the necessary switchboard, etc.

Dr. Groves, owner of the electric lighting plant at Fergus, Ont., has installed in his power house a 75 k. w. S. K. C. two-phase alternating current generator made by the Royal Electric Company, Montreal. The doctor intends to supply power as well as light in the town in the future.

The Bell Telephone Company have installed a new switch-board in the exchange at Parkdale, Toronto. This exchange is designed after the one in Ottawa. A light burns in front of the telephone operator when two subscribers have been connected, and continues to burn until both parties have hung up their receivers again.

Mr. James A. Spence, of Colborne, Ont., owner of the electric lighting plant, and who had his plant destroyed by fire a short time ago, is rebuilding, and has placed his order with the Royal Electric Company for a 75 k.w. S.K.C. generator, complete with exciter and station apparatus. They were in running order three weeks after the fire

Messrs. *Brandon, McDougal & Austin, owners of the Fenelon* Falls electric light plant, are increasing their lighting capacity, and have placed an order with the Royal Electric Company for one of their 75 k.w. S. K. C. two-phase generators, as well as for a number of transformers and a stock of supplies, and intend over-hauling and improving their present plant.

The Canadian Gold Fields, Delora, Ont., who own extensive gold mines at that place, have equipped their mines, offices, houses, etc., with electric light and power. They have placed their order with the Royal Electric Company for a 40 k.w. S.K.C. two-phase generator, with the necessary transformers and supplies. They purpose furnishing light to their employees.

The Nickel-Copper Co., of Ontario, whose large refining works are at Hamilton, have begun operations on a large scale, and have placed in their new power house two 240 k.w. and one 75 k.w. S.K.C. generators; the former to drive the dynamos for the electrolytic process and the latter to drive the ore process. These three machines are being used as synchronous motors, taking the current from the Cataract Power Company's lines at 2,400 volts.

Shipment was made a few days ago of the largest motor that has yet been built in Canada. The motor was consigned to the British American Corporation, of Rossland, B. C., and the shipment made by the Royal Electric Company, Montreal. The motor is an S.K.C. two-phase machine, and its capacity is over 1000 h. p. It is to be used to drive the compressors and hoists at the mines. The total weight of the motor, boxed, ready for shipment, was 105,000 pounds, or 52½ tons. The weight complete of the motor with its accessories was over 120,000 pounds, or 60 tons, requiring two full cars to transport it.

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