TRANSACTIONS and YEAR BOOK

of

The University of Toronto Engineering Society

April, 1928

TRANSACTIONS and YEAR BOOK

of

The University of Toronto Engineering Society

FACULTY OF APPLIED SCIENCE AND ENGINEERING

SCITE ET STRENUE

April, 1928

THE LITTLE RED SCHOOL HOUSE

CONTENTS

John Galbraith, M.A., LL.D. 13

Editorial 15

Technical Service Council 17

Dean's Message 19

Address of Retiring President 21

St. Lawrence Waterway Project 23
DEAN MITCHELL

The Corrosion of Metals 38
A. R. BATTYE

Work of the Aeronautical Laboratory 55
J. H. PARKIN, M.E., F.R.Ac.S.

The Semi-Centennial of School 65

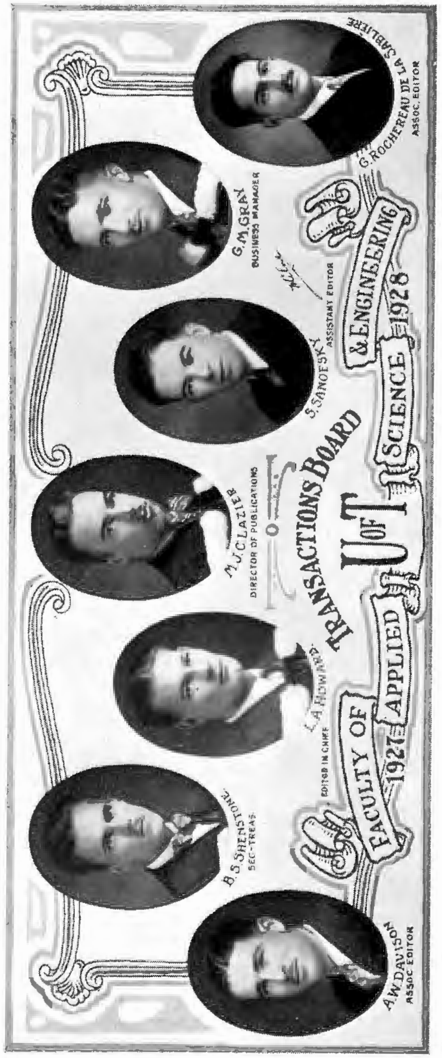
Review of the Year's Activities 73

John Galbraith, M.A., LL.D., 1846-1914

John Galbraith, honour graduate in Mathematics of the University of Toronto, he who first organized the School of Practical Science and carried it safely through a period of doubt, and even scorn, to a most successful issue—the man of vision and action who foresaw that the future greatness of his beloved country, Canada, was dependent on an educated group of engineers and that they must be prepared for this work before the country's need became imminent. Thus, when Canada required a survey, a bridge, a road, a dam, or an industrial plant, there were sons of Canada ready to design, to erect or to build and supply this need.

To have studied under his guidance was a privilege, which there are many to affirm; to have graduated under his tuition and have served under him was a rare opportunity, of which there are quite a few to give testimony. Most exacting in study and research but kind in heart, he was the creator of the "School" spirit, and his memory is now cherished by every school man.

To his memory the graduates paid tribute as his bust, the gift of his boys, was unveiled at the Semi-Centennial of the Faculty.



Transactions and Year Book

of the

University of Toronto Engineering Society

With which is incorporated "Applied Science"

PUBLISHED ANNUALLY BY THE SOCIETY

No. 41 — TORONTO, APRIL, 1928 — Price 50c

M. J. C. Lazier - - - *Director of Publications*
Lewis A. Howard, Jr. - - - - *Editor-in-Chief*
Sam Sanofsky - - - - - *Advisory Editor*

George M. Gray — *Business Manager*
B. S. Shenstone — *Secretary-Treasurer*
G. Rochereau de la Sablière — *Associate Editor*
W. A. Davison — *Associate Editor*

Editorial

An editorial is a necessary evil in all publications. It offers wonderful scope for imagination, criticism and exaggeration. However, truthfulness, the fundamental quality of the Engineer, should be the dominating characteristic in a technical magazine of this kind.

If our frankness has led to offence we apologize, and for any mistakes or omissions we are sorry—it is our loss.

Criticism is invited, for it may save future generations from committing our errors, and bring Transactions closer to the objective set by every editorial staff.

The bust of Dean Galbraith, recently unveiled in the hall of the Mining Building, has been donated by his boys in loving remembrance of one whose service and friendship to all has made his memory very dear to those who knew him.

The Engineering Society Executive deserves a great deal of credit for a successful, if not an exceptional year. This year has been the Centenary of the University, and the Semi-Centennial of School, and, as such, it has offered to the officers of the Engineering Society, on the one hand, a wonderful opportunity for an exceptional and outstanding year, and on the other the increased chance of failure. Our President, Bill Duncan, with the support of a hard-working Executive, returned last fall with the object of making the Semi-Centennial of School one that would long be remembered. It is to the energy and activity of the Executive, the untiring efforts of Stuart Bolton, and, above all, to the support, organization and loyalty of Professor C. H. C. Wright, that School owes the credit for a wonderfully successful celebration.

It was no easy task for the Executive to start a term of office with a Celebration that comes only once every hundred years, but they succeeded, and in each activity they have undertaken they have shown whole-hearted interest and capable management that they may well be proud of. Gord. Adamson has proved himself an outstanding 1st Vice-President, not only in his attention to the duties of his office, but also in his splendid work on committees and his interest in every line of activity. This year the Constitution received a much needed revision, and there is every chance that the books will balance at the end of the year with a considerable profit.

To France Trimble goes the honour and our congratulations for being the first man to win the recently established Athletic Shield for the most outstanding School man in University Athletics, decided upon by a majority vote of all the members of the Engineering Society.

And next year Morley Lazier goes to Cambridge with a Massey Scholarship tucked away at his belt, a prize which was hotly contested and well merited.

Although there have been many splendid addresses delivered before the Engineering Society this year, only one has been chosen, namely, the address delivered by Brig.-Gen. C. H. Mitchell, on the St. Lawrence Waterway Project, which is a subject of exceptional interest to all Canadian Engineers. As a member of the Engineers Committee appointed by the Government to report on the project, Dean Mitchell was in a position to give an address which was extremely interesting.

Professor Parkin's paper on "The work of the Aeronautical Laboratory of the University of Toronto" deals with a subject which has been studied and developed a great deal during recent years, and is of interest to every Engineer in Canada.

In the Year Book is published an article on the Semi-Centennial Celebration, written by Professor C. H. C. Wright, who has been "in the thick of it". The Board of Editors wish to take this opportunity, on behalf of the Engineering Society, of thanking Professor Wright for his untiring effort in making the Semi-Centennial of School the success that it has been.

An endeavour has been made to pick a Thesis from the fourth year list which would be of interest to more than just a minority, and in A. R. Batty's paper on "The Corrosion of Metals" will be found some interesting data.

The staff are grateful for the assistance received from faculty and students. Whole-hearted co-operation is the mainstay of any organization, and this co-operation has been shown by all who are interested in the welfare of TRANSACTIONS.

THE TECHNICAL SERVICE COUNCIL

Each graduate in Engineering costs the Government $2,000 for his university training.

(From report of a Committee of the Engineering Alumni Association of the University of Toronto.)

Of those who graduated in Engineering in the University of Toronto during the 10 years ending 1926, 224 have gone to the States.

(From the 1927 Report of the President of the University of Toronto.)

"The University is one of the best efforts of the State. It is a successful effort; its standards and its attainments are recognized as of the highest throughout the world. The University takes a selection of our partly processed finest natural material, our young men and women, and processes it still further, presumably for the benefit of the nation. For the manner and methods of this processing, the whole world is drawn upon and we are justified in believing that the results are the best obtainable for laying the foundation for the filling of the highest as well as the every day needs of the nation. So much is this taken as a matter of course that the product is expected to sell itself, a condition of affairs very different from other production.

The very essence of modern operation is selling. Even the profoundest of truths must in these days be sold, expertly sold, or they are not absorbed or assimilated. This selling has become such a universal, such an insistent all pervading process that where it is absent there is no progress. The public does not recognize value in goods or in ideas unless there is insistent publicity in selling. The use and meaning of the word have changed as well as increased. Not only are goods sold but the man is "sold". A man must be sold on the value of a car before he buys the car. The nation is not sold on the value of our educational products (and this includes the products of the Technical and High Schools as well as of the Universities) except in a very general way. We do not know these products nor their possibilities. Even the producers, the educationalists themselves, have probably but faint realization of their possibilities, all along the line from junior assistants to, later on, general manager. The modern salesman develops more uses for his product than do the designing and production departments. There is no part of our commercial life that would not be improved by the development of the uses of this, our most complex natural product.

Is it not, perhaps, our greatest national need that employers be sold on our educational products?"

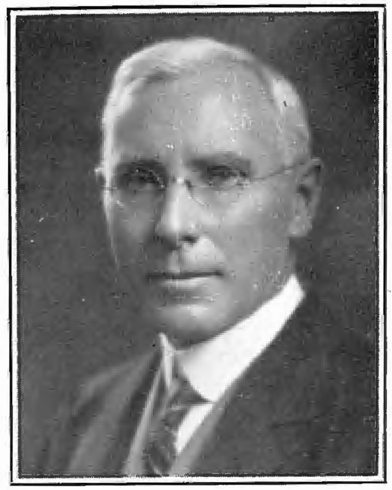
(From an editorial in "Industrial Canada", January, 1927.)

There has recently been established in Toronto an organization known as the Technical Service Council, with an Advisory Board consisting of Dr. H. J. Cody, Chairman; Sir Edward Kemp, Sir John Aird, S. R. Parsons and C. A. Magrath. Something more than $30,000 has been subscribed by influential men and companies to carry on this "patriotic experiment" for the first three years.

Its main function will be to "sell" the idea of the usefulness of the Engineering graduate to the manufacturers and employers of Ontario and to develop the useful reactions resulting. It is hoped that it will develop into a Dominion-wide organization later on.

The affairs generally of the Council will be under the control of an Executive Committee. The business of the Council will be conducted by a Director and an office staff with suitable office accommodation. One of the first things to be done will be to collect a great deal of information in regard to graduates—both recent and older ones—those resident in Canada and those elsewhere—their experience and their qualifications. Simultaneously information will be obtained in regard to all kinds of industries in Ontario and the possible openings they might have for technical graduates. A study will also be made of the methods of the big organizations in the United States who employ large numbers of technical men and have special training courses for them after their graduation. All this information will form the basis for the activities of the Council. It goes without saying that one of the functions of the Council will be the bringing in touch with each other of prospective employers and employees.

The Dean's Message for 1928



To the Class of 1928,
Faculty of Applied Science and Engineering.

Gentlemen:

Your class has made a name for itself in the University the past four years and you are to be congratulated. The Hundred Men of Twenty Eight will carry a special mark and they will always carry their heads high.

The Engineering Society, to which members of your class have contributed very much, has completed a most successful year. The Society has had a high standard of addresses, valuable and varied in their subjects, both in engineering and in general. A most outstanding feature has been the careful business administration and financing of the Society. It has been a year, too, of very successful functions and activities. In all of these the members of the Class of 1928 have, together with their colleagues from the other years, played a very influential part.

The past several years, when you have done me the honour of asking me to contribute the foreword to the TRANSACTIONS, I have drawn to your attention the increasing signs of an approaching period of prosperity in Canada. It is most gratifying to realize that this prosperity has now arrived and we are well into it, as is evidenced by the remarkable progress achieved in 1927. The turn of prosperity has come almost with abruptness. Once the turn was made, better times begat better, and now they bid fair to beget still better.

Never before has Canada experienced such a year of general prosperity and progress as we had in 1927. It is a happy coincidence that this should have been the celebration year of our Confederation, and better still that it should have coincided also with the Hundredth Anniversary of the University and the Fiftieth Anniversary of the founding of this Faculty.

You are fortunate, then, in being at the University at this time and in going out into the professional life of the country in this year of 1928 when it is awaiting your coming. Canada will now need all its engineers and applied science graduates to help in the development which is before us. The best advice I can give is to stay in Canada and help in this; it is not only your duty to the country and your university, but it will surely be to your advantage.

I wish you all success and good fortune.

Yours faithfully,

C. H. MITCHELL,

Dean.

Address of Retiring President

GENTLEMEN OF S.P.S.:—

It is with mingled feelings of regret and satisfaction that I prepare this address which marks the end of my term of office.

Regret, not only that experienced by every fourth year man as he faces the prospect of severing the many ties of friendship made during his years at Varsity, but I particularly regret the conclusion of my active connection with the Engineering Society. The prevailing spirit of hearty co-operation among the officers and members of the Society has made all my work in this connection a pleasure which I shall long remember.

While the activities of the Society during the past year have not been devoid of mistakes and errors, I feel that we have some reason to believe that the year as a whole has been quite successful. The measure of success achieved by the Society is, I believe, in direct proportion to the co-operation given the executives. Therefore, gentlemen, whatever success has been ours this year is entirely due to this co-operation.

The regular meetings of the Society have as a whole been well attended. Our policy in regard to these meetings has been threefold.

(1) To select speakers of unquestionable merit.
(2) To select subjects of general interest.
(3) To change the date of our meeting when necessary to suit the speaker.

The opportunity to hear the men who address the Society is a privilege which apparently the junior years do not fully appreciate. If the standard of speakers at the Society's meetings is to be kept high, good attendance is essential.

Our financial statement as printed elsewhere in this book is very commendable. The credit balance is directly due to the efforts of our Treasurer, Jack Wright; 1st Vice-President, Gord Adamson; 2nd Vice-President, Reg. Rochester; and Babe Smith, Chairman of School Night Committee. Special mention should also be made of Stew Bolton's untiring efforts as Chairman of the Centennial Committee.

And now, gentlemen, allow me to express my appreciation of the confidence you have placed in me in electing me to the office of

President of this Society. It has been a great honour and a great privilege. To the members of the executive and of the Society who have been so generous with their assistance and co-operation I am indeed very grateful. I would also like to take this opportunity to thank the Dean and the members of the staff for their invaluable advice and assistance.

To Reg. Rochester, your new President, and his executive for the coming year, I wish every success. May they receive your continued and wholehearted support.

As ever,
Yours most sincerely,
W. A. DUNCAN.

THE TRANSACTIONS

OF THE

University of Toronto Engineering Society

WITH WHICH IS INCORPORATED THE "APPLIED SCIENCE"

No. 41 **TORONTO, APRIL, 1928** **Price 50c.**

The St. Lawrence Waterway Project

By BRIG.-GEN. C. H. MITCHELL, C.B., C.M.E., C.E.

Dean of the Faculty of Applied Science and Engineering, University of Toronto

March 5th, 1928

It is with a great deal of pleasure I speak again to the Engineering Society on the St. Lawrence question. You will recollect that on the 20th October, 1926, I gave an address on this subject in a general way at the inaugural meeting of the Society for the year, and on that occasion—as you will remember from the Transactions, which I expect you all have—I discussed the problems of the St. Lawrence and the Great Lakes, and in that I tried to tell you in advance some of the large technical and other problems that were before the Engineers and before the people who are studying this question, and also before the country. And on that occasion I discussed those problems under several heads. One was Geographical; another was Physical; another was Economical; then Commercial, Financial and Technical; and then I went on and dealt with those in turn, ending up with a number of arguments that had been advanced both against and for the project by different people. They were not my own views; they were views that one picks up through publications of various kinds throughout the country.

It is a thousand miles from the sea to Montreal and fifteen hundred miles from Montreal to the Head of the Lakes. There is a total fall at the Soo on the St. Mary's River of about twenty feet. There is a total fall on the Niagara of something upwards of 325 feet. There is a total fall, lake and river, from Lake Ontario to Montreal of 225 feet. Those added together make 570 feet. There are, in addition, slight falls in the St. Clair and the Detroit Rivers, and there is about 20 feet fall from Montreal to the sea. These, along with other small slopes, make up the 600 feet of the total from Lake Superior to the sea. If you tried to put all of that fall into power, you would get something over 10,000,000 horse power. That is probably the ultimate potential horse power of this total fall from Lake Superior to the sea, but of course, it is not all capable of being obtained.

I will now put on a slide of a map of the St. Lawrence River proper from Lake Ontario down to Montreal. On this map you will observe that the portion to the left, or westerly part of the river, is the international portion, and the international boundary between Canada and the United States leaves the river at a point just below Cornwall, and runs along towards New Brunswick. That portion above Cornwall is known as the International section of the St. Lawrence, and you will hear it spoken of a great deal in various ways in that sense, and the portion below is the National section, in the Province of Quebec. The portion that is in the international section is practically all Ontario.

The Navigation Situation

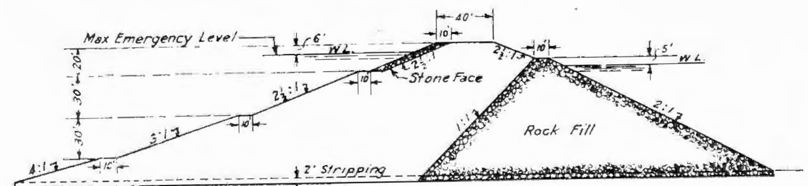
Now, having gone that far in a very general way, I want to discuss the navigation situation as it is today, and deal with that first, because the whole question of this St. Lawrence River, as you will doubtless have seen in the Press and in reports, revolves primarily around navigation, for under international and national law navigation is primary, and power, while it is much the more valuable probably, is secondary. You will sometimes see legal decuments and see reports in which power is looked upon as a by-product of the improvement of a river for navigation.

The present navigation down through the Great Lakes and to Montreal, is limited at the present time by the sizes of the locks and the canals, in the Welland Canal and in the St. Lawrence Canals. The depth of those canals being only 14 feet, and the locks being only 45 feet wide and 270 feet long, limit the size of the boats that can use them. In the way of grain-carrying capacity, it means that a boat that carries grain through the canals and lakes as they now are, through the Welland Canal and down the St. Lawrence Canals as they now exist, would probably be able to carry not more than 80,000 bushels of wheat for instance. If, however, the great grain-carrying boats that are on the Great Lakes above the Welland Canal, being much larger, 600 feet long and 60 feet wide with 21 feet draught, and carrying from 400,000 to 500,000 bushels of wheat, could go straight down through to Montreal it would make all the difference. If the Welland Canal were enlarged—as it will be when completed in three years' time—and if the St. Lawrence were developed and increased in size, to the same size as the new Welland Canal, those large boats could go through to Montreal, and if they were suited in their type, they could go out into and across the ocean.

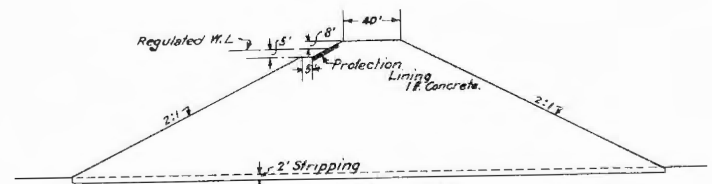
Thus you will see there is a limitation imposed at the present day by the present Welland Canal, and there is a limitation of the same kind imposed by the present St. Lawrence Canals. Three years hence when the Welland Canal is completed—the new one, to a depth of about 27 feet—those large grain carriers operating on the Great Lakes will be able to go down into Lake Ontario, but

even then they will not be able to get out of Lake Ontario and down to the sea, because they will still be limited by the St. Lawrence. Consequently, we in Canada, and the United States people as well, are thinking what we are going to do with regard to Upper Lake grain trade when the Welland Canal is completed.

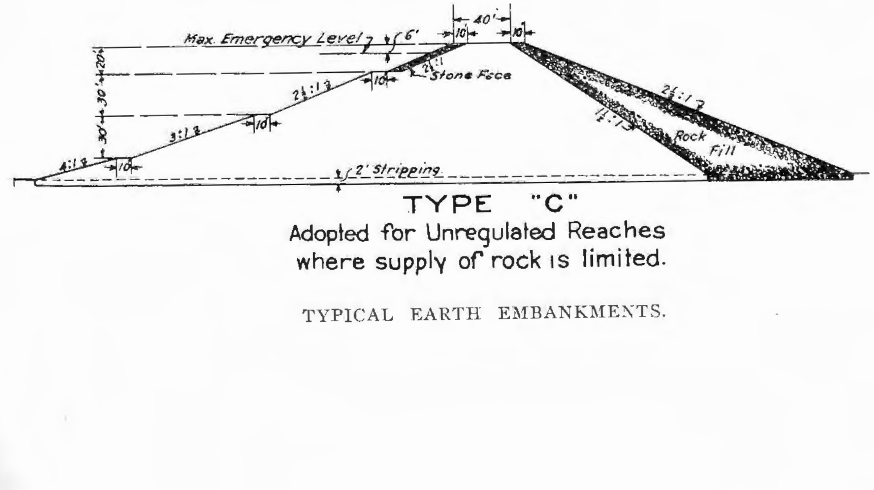
As doubtless you have seen in the Press at various times, it is proposed to build terminals somewhere at the foot of Lake Ontario or in the upper waters of the St. Lawrence River whereby these large ships can be emptied and the grain taken on down, either in smaller boats or by rail, to the elevators and the ocean ships at Montreal or Quebec. That is why you see a good deal of talk in the



TYPE "A"
Adopted for Unregulated Reaches where rock is available from excavation.



TYPE "B"
Adopted for Regulated Reaches



TYPE "C"
Adopted for Unregulated Reaches where supply of rock is limited.

TYPICAL EARTH EMBANKMENTS.

papers about the probable development of a terminal at Kingston, or at Brockville, or at Prescott.

Whether by agreement or not, I do not know, but it is a fact that Canada has spent practically all its money in the way of improvement on the Great Lakes system in the part that extends from the sea up to Lake Erie. But the United States, on their part, have put all their money into Lake Erie, the Detroit River, Lake St. Clair, the St. Clair River and the St. Mary's River at the Soo, where they have built several locks. They have spent altogether upwards of $40,000,000 in the Upper Lakes. We, on our part, have built the Welland Canals. The one that is being completed is really the fourth, between the two lakes, and this new one will cost about $115,000,000. We have built the St. Lawrence canals as they exist now, and we have deepened the St. Lawrence River from Montreal to the sea to a depth of about 32 feet at a cost of upwards of $35,000,000.

Trade and Water Transportation

With regard to the matter of trade, I think it will be useful here to say just a few words about the extent of trade on the Great Lakes at the present time.

It is a rather extraordinary thing that the shipping on the Great Lakes, so far as tonnage is concerned, has been very rapidly increasing in the last few years. This can most readily be seen by the following tables of statistics of tonnages through the Welland and the St. Lawrence Canals. The interesting thing in connection with this is that more than half of it, all the way along, originated in Canada. It was Canadian tonnage, Canadian freight. It may not all have been carried in Canadian ships—I do not think it was—but it certainly originated in Canada, and it was mostly grain, of course.

THROUGH PRESENT WELLAND CANAL

Tons of Freight Carried

Year	Originating in Canada	Total
1912	1,553,116	2,851,915
1916	1,054,480	2,544,964
1920	717,452	2,276,072
1922	1,802,605	3,391,419
1924	3,148,417	5,037,412
1926	3,457,876	5,214,514
1927	4,483,834	7,247,459

THROUGH PRESENT ST. LAWRENCE CANALS

Tons of Freight Carried

Year	Originating in Canada	Total
1912	2,240,143	3,477,188
1916	1,581,195	3,368,064
1920	1,285,272	3,067,962
1922	2,649,585	4,319,919
1924	3,731,869	5,536,374
1926	4,350,841	6,123,701
1927	5,400,615	7,912,952

But there comes a limit, of course, to the carrying capacity of these canals. There are the St. Lawrence Canals as they now exist, actually worked to their limit when they get 8,000,000 tons of freight through in a season. Of course, you can work out the capacity of a navigation canal just the same as you can a railway, or a water pipe, or a drain, or anything else. It has certain capabilities in time and effectiveness.

Well, now, if the new St. Lawrence navigation canals were built, and if the Welland canal were finished, you can just imagine what the great increase and the capabilities of this traffic would be, in being able to push those vessels right through to an ocean port And that raises the question as to what kind of trade would likely accrue. There are some people who say, "Oh, well, if you get the Lakes opened to sea vessels, so that sea vessels can go up, or so that lake vessels can go down, they probably won't go, there won't be the business for them." Well, there are some arguments against it, but I do not think they are very strong. By far the greatest weight of argument is the other way, that the ocean vessels will go up and that lake vessels, in due course, will probably be made of different types and they will come down but not necessarily cross the ocean. Certainly, the present lake vessels could come down as far as Montreal and unload; there is no doubt about that, if they had the size of canal necessary.

What does that mean with regard to trade? I have tried to visualize it by dividing it into three classes, putting perhaps what is the most important first, because it develops the country probably more, that is, Interprovincial trade. I am just trying to make a picture of what you could imagine, of traffic from Nova Scotia up the Gulf, up through the River and up the Lakes to the interior.

And then a second class, what might be called National trade, trade that could come down from the lakes and could bring cargoes to these ports for trans-shipment to ocean vessels. It is pretty sure that Montreal and Quebec, and possibly some other port down in the Gulf, will be greatly benefitted. I am inclined to think that the Montreal people are beginning to feel now—certainly their Harbor Commission feels it, and the Quebec Harbor Commission feels it too—that they have a great deal to gain by the construction of enlarged navigation on the St. Lawrence, because they will get a tremendous increase of freight, freight brought down to be transshipped from their ports.

Then there is the third class, which might be called International trade, that is, coming down from the Great Lakes, out the St. Lawrence and across the sea, over to England or Europe, or to Atlantic ports down into the United States. And when you think of it, that is the main thing that the United States people want, what they hope to get out of the new Canal system, because they will be able to ship from the interior of their country down through the St. Lawrence, and down along the Atlantic coast, even although the trip across by rail is much shorter in mileage.

As a proof of this just let me give you some figures with regard to two of these features of trade. Take, for instance, the Interprovincial trade. Take the trade in coal, we will say, from Nova Scotia. Last year there was a total of 1,600,000 tons of coal brought up from Nova Scotia to Montreal harbor, and that was brought in 178 vessels, averaging 9,000 tons apiece.

Then take the International trade across the sea, also with coal. There was a total of 767,000 tons of coal brought into Montreal from across the sea, and of that 683,000 tons was from Welsh and Scotch mines, and this coal was brought in 135 vessels averaging over 5000 tons each. Now, none of those vessels could get up the St. Lawrence past Montreal today if they tried, but if the St. Lawrence were deepened to the 27 feet, as discussed, they could all come up. They could all come up through, not only to Toronto, but to the Head of the Lakes. You can see just in coal alone, what that might mean.

The Power Situation

With regard to the power situation, the other side of this great project. The Province of Ontario today is in great difficulty for power. Last year there was 950,000 horse power being supplied by the Hydro-Electric Power Commission of Ontario, and that is the limit at the present time, but in order to safeguard the future, there being no new power in sight, the Hydro-Electric Power Commission has within the last two years made contracts aggregating

EFFECT OF ICE JAM AT LONG SAULT RAPIDS.
Rapids flooded out by jam packing up river from below. Rapids have temporarily disappeared (Jan. 1925).
View looking upstream from head of Barnhart Island; Sheek Island on right.

360,000 horse power more, to be brought from the Ottawa River. But the Chairman of the Hydro-Electric Power Commission says that at the very best, making allowance for the normal growth of industry and the demand, this is not good for more than four or five years, and that if there are any abnormal demands it will not be nearly sufficient.

It is quite obvious then that more power must be secured, and the only sources to get it from, in any large amounts, are either from Niagara Falls by getting more water, which perhaps may come before long—and only a limited amount at that—and from the St. Lawrence River. And, for that reason, the power demand will be a very potent factor in demanding the early construction of this great project.

In speaking of this undertaking we must realize that it is the largest project that has ever been discussed in Canada in the way of public works, not only in money but in size, in potentiality, and in economic adventure.

As a canal it would be easily not only second to the Panama but in some respects larger than the Panama, because it would have to overcome 225 feet of height which is much greater than the Panama, and the locks would have greater lifts.

Control of the Great Lakes

Now, I am going to say just a few words with regard to the regulation of the Great Lakes, because that has been a part of this great problem and there has been a great deal of talk about the levels of the Great Lakes. One object of the Engineering Board was to devise a scheme whereby the lowering of the Lakes could be arrested, and if possible rectified. It was found that it could be rectified with great difficulty, that the levels could be restored only within limits. It was also found that contrary to expectation it was not economically feasible to do this by means of regulating works. By regulating works I mean works that will enable the level of a lake to be artificially fluctuated by means of dams and sluices. The lakes are so very large, as I explained to you last year, that it is not a matter of days, it is a matter of months and years, to lower or raise their levels. It was found that the cheapest and the easiest way of doing it was by means of compensation, that is, letting nature do the regulating after the compensation had been made.

You will remember that last year I explained that the fall of the lakes was due to a number of factors. The Chicago diversion was only a part. The largest factors were the lack of rainfall, and the continuation of the very great evaporation that goes on winter and summer.

Just in a word, what is now proposed to be done is this, leaving out Lake Superior which is now actually regulated. What is now proposed with regard to Lake Huron and Lake Michigan—they are the same level—is to throttle the St. Clair River near Sarnia by means of weirs in the bed of the river. Of course, it will take a long while to do this, but it will mean getting the water back on Lake Huron to the extent of 12 inches. That is the most the Board found it could do, but that is feasible at a reasonable cost of something like three or four million dollars. Then the same thing down at Lake Erie, by throttling the Niagara River just below Buffalo and opposite Fort Erie, thereby raising Lake Erie 9 inches.

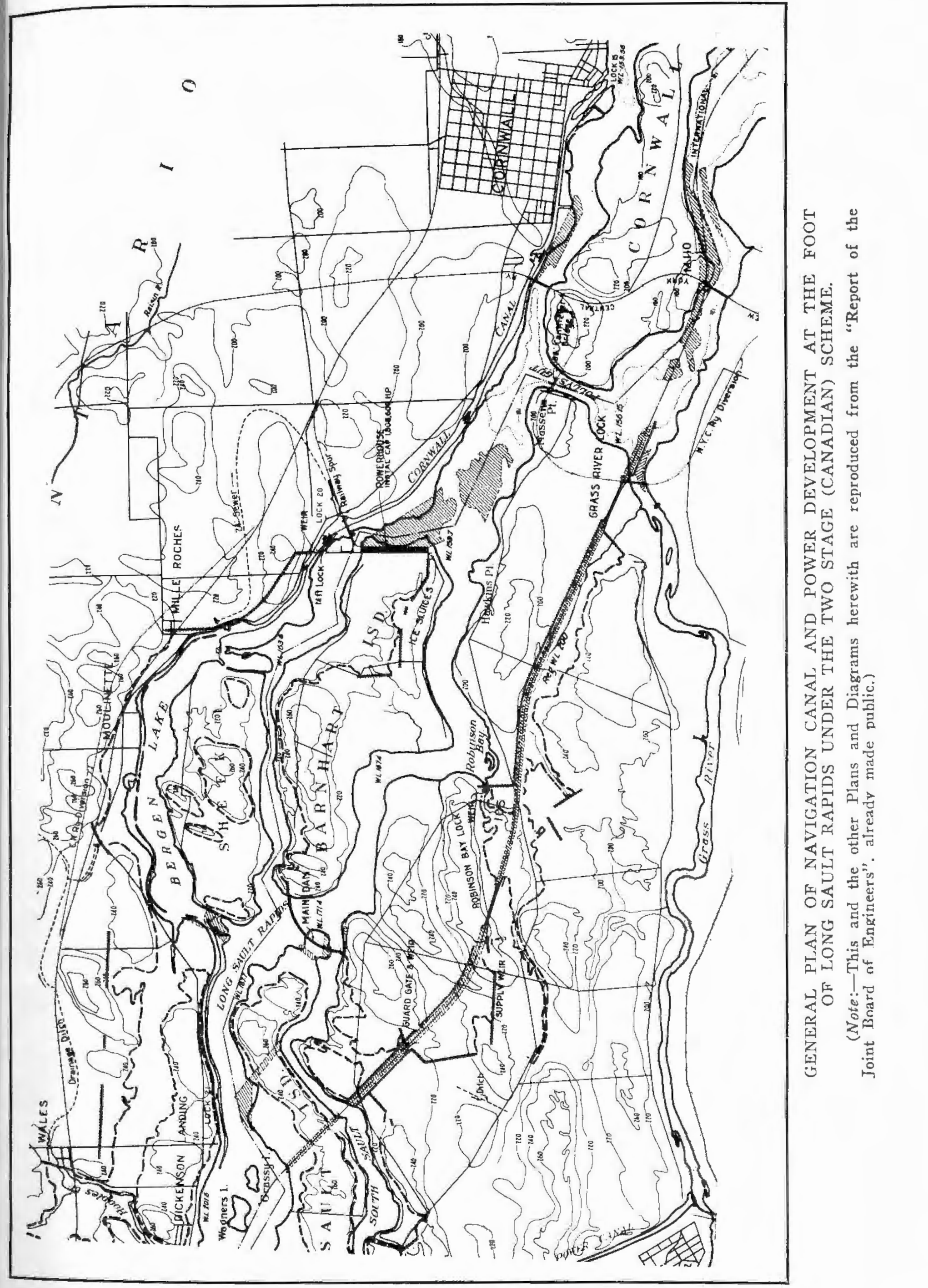
Then comes the question of Lake Ontario. Well, of course, Lake Ontario being the head water of the St. Lawrence, any dam that is built in the St. Lawrence would hold the level of Lake Ontario, and that, becomes then a regulated level.

I am going to throw on two or three slides for the benefit of those of you who are studying hydraulics. In the first there are the permissible levels of the Great Lakes in various months. And here in another is the maximum allowable discharge for the St. Lawrence River. I told you last year that the discharge ran from 180,000 cubic feet per second to 220,000 under normal conditions, and you will see by this that in January and February the allowable discharge for Lake Ontario,—the level of Lake Ontario at 246 feet above sea-level—a little over 200,000 cubic feet per second; so if Lake Ontario should drop to elevation 243, which is not far off what it is today, probably it would drop to about 190,000 or less. Then in March, and in April, and in the summer time it increases up to 245,000.

The Navigation Canals

With regard to the Canal, you have heard talk about the navigation route and the location of the canal itself. You have heard about the possibility of a canal being built wholly in Canadian territory. When the International Engineer Board sat down four years ago to try to work this thing out they started by trying to do it as a straight engineering proposition. They tried to get at what was the best and most economical engineering design irrespective of whether it was in Canada or the United States, and that idea was carried out fairly well until near the end, and then, of course, they found there were quite a few difficulties in the way. But when you consider that the international boundary on the St. Lawrence River switches from one side to the other all the time, taking in one lot of islands on this side, and then on the other, and so on as it goes down the river, you can see the difficulties. Someone counted up not long ago, I think, the number of times the international boundary crossed the channel of the St. Lawrence and stated it was some 60 times; I have not verified this.

As I will show you in some slides I am going to put on, the proposed new St. Lawrence canals proper, as designed by the Engineer Board, cover roughly about 25 miles of the total distance, which between Lake Ontario near Kingston and Montreal is 180 miles. Much of that total distance is smooth water at the upper end, there being a stretch of 70 miles through the Thousand Islands to Prescott which is Lake Ontario level. Of the 25 miles of canals only about 7 miles are in the International section and these are located in U.S. territory. The deep channel is for the most part on the United States side through the river portion of the International section. If the Engineer Board had tried to get a channel wholly



GENERAL PLAN OF NAVIGATION CANAL AND POWER DEVELOPMENT AT THE FOOT OF LONG SAULT RAPIDS UNDER THE TWO STAGE (CANADIAN) SCHEME.

(*Note*:—This and the other Plans and Diagrams herewith are reproduced from the "Report of the Joint Board of Engineers", already made public.)

through the Canadian side they would have had to deal with great masses of rock and islands, through the Thousand Islands, in order to get a fairly straight route, and that would have made the canal in this region practically prohibitive in excessive cost. It would have run probably to tens of millions of dollars more. Some day it may be done however, but it would not be economical to-day.

Then in that part down around the Long Sault Rapids, which is just above Cornwall, there was the choice of going on the Canadian or the United States side. The best location was selected as being on the United States side; it was cheaper, and it was shorter and it was better in several features.

Now, I say that the total length of the actual navigation canals in that whole distance as proposed is less than 25 miles. That is a great achievement when you think of it, that out of 180 miles only 25 miles or less would be in actual canal. There are to be, under this design, only nine locks at the most, and the canal would be crossed by only eight bridges in the whole distance; those would be lift bridges. There may be one or two bridges subsequently built that will be high up like the new Montreal bridge which is 150 feet above the water. That gives you some idea of the care with which the design of this canal has been carried out.

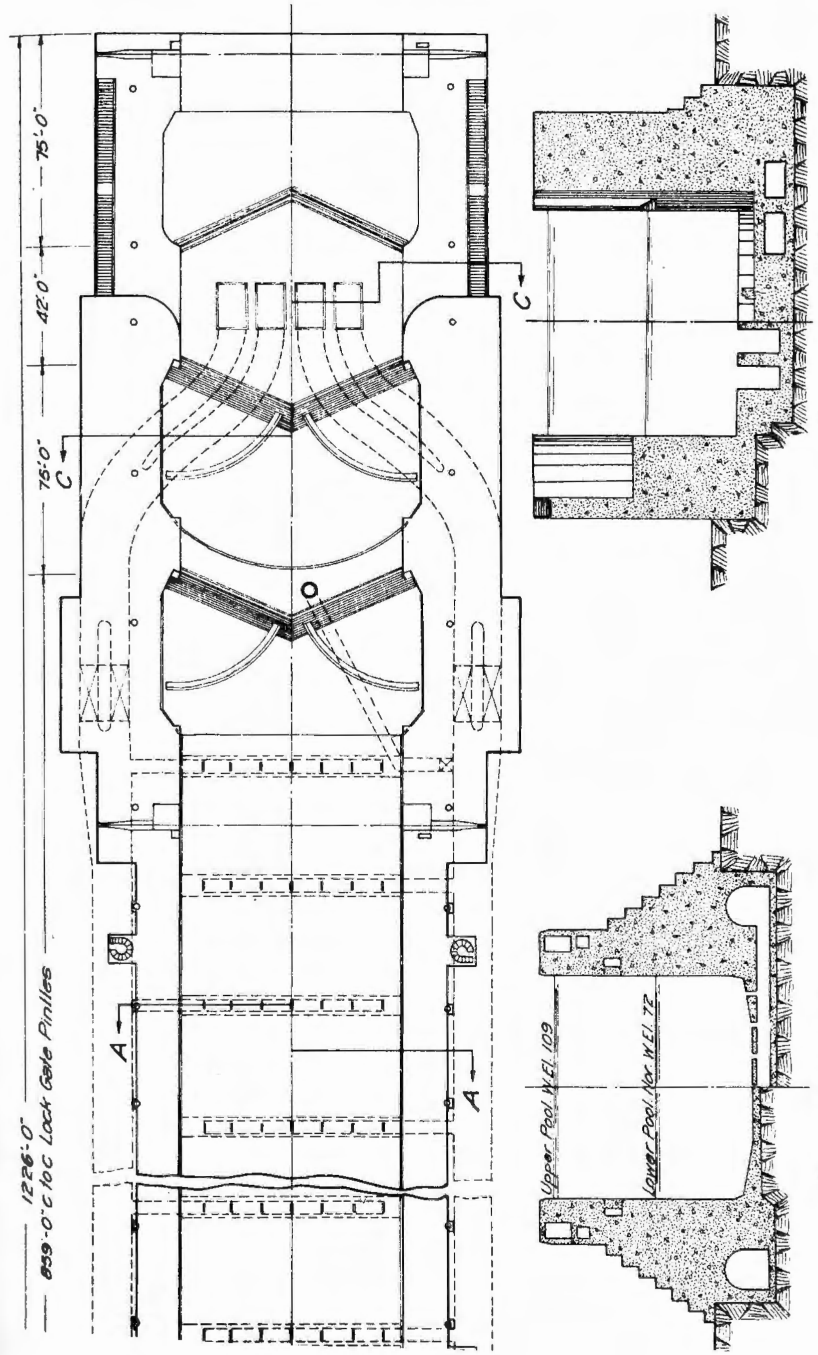
With regard to the depth and the size, I have already given you some idea of that. The Engineer Board said 25 feet in their report. However, from what one hears, it is likely that the two countries may agree on 27 feet, two feet more than the engineers agreed on. And if it is 27 feet in depth that means, so far as draft is concerned, that about 70 per cent. of all the freight tonnage of the world can come up from the ocean into the Lakes; that is, according to Lloyd's Register, which is a very large proportion. That means a depth or a draft of 25 feet out in the ocean, and 25½ feet draft in fresh water, because in fresh water a vessel rides deeper, and it takes up about 6 or 7 inches more draft.

The length of the locks is recommended to be 859 feet, the width 80 feet, and the depth 30 feet. That is what you see in the new Welland Canal and it is proposed to be the same size exactly. The magnitude of locks of that size is rather hard to conceive. Any of you who have been down in one of these locks on the new Welland Canal can realize the size of them.

Talking about estimates, I hope that one day some of you will be involved in large estimates, because it is exceedingly interesting. But let me give you this suggestion: Never lose sight of the relative magnitude of the amounts of money. If you have been in the habit of working perhaps in hundreds of thousands of dollars and you suddenly find yourself engaged on a project where you are thinking in millions and tens of millions, you are apt to lose the sense of proportion very rapidly.

The Ice Problems

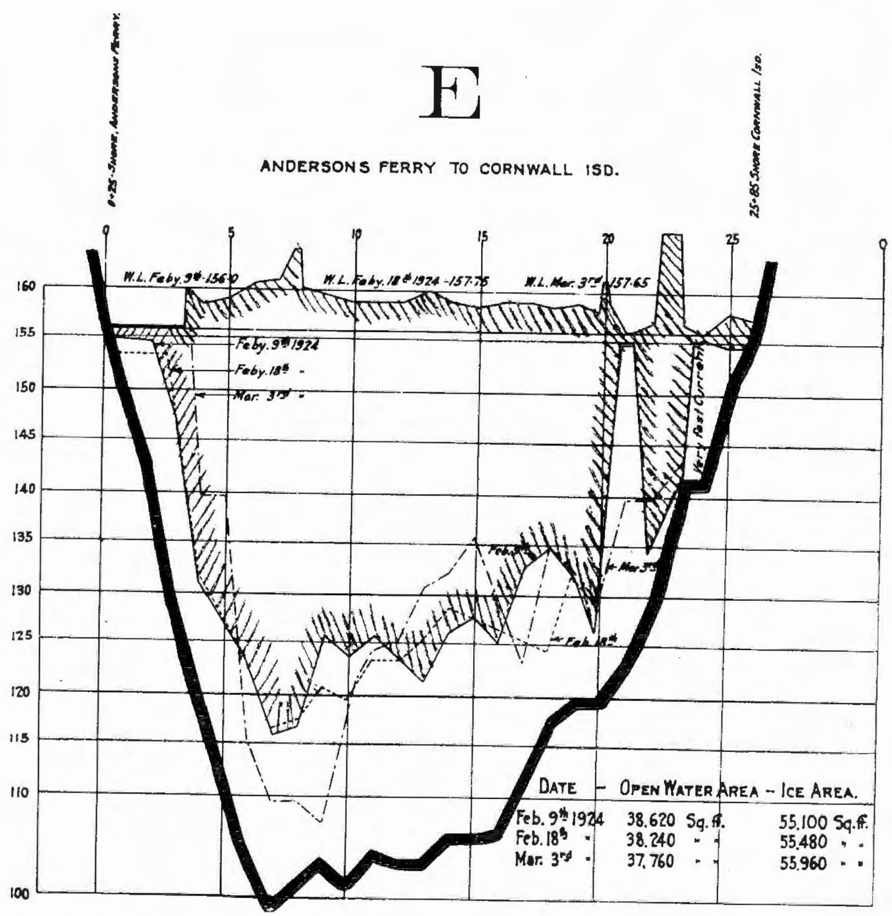
I said something a year ago with regard to the great ice difficulties, and the ice troubles and problems on the St. Lawrence which



SECTIONS AND HALF PLAN OF TYPICAL LOCK.

are exceedingly great. The difficulty is that with fluctuating levels and very cold weather the ice is apt to form itself into ice jams.

You must keep in mind that floating ice has a momentum in itself and you cannot make it flow just like you can make water flow. Water may be flowing in a certain direction and a slight change of its direction take place, but the ice floating on its surface will go on straight for a while. The Engineer Board found out some important things. Ice that is flowing in velocities up to two and a quarter feet per second along the surface of a stream will form itself into an ice cover just like a sheet of ice, only it will be made up of small pieces. Then if the velocity is increased to three feet a second that same ice will go sliding along beneath, will duck under the surface, and instead of forming itself into a sheet it will form



TYPICAL WINTER CROSS-SECTION SHOWING HANGING DAM OF ICE; ICE SHOWN SHADED.

itself into a great hanging dam or bridge of ice over the top of the water. I mean floating in the water but decreasing the water section underneath. The greatest of care has to be taken to secure the largest possible section of water in the winter time under the ice covers or ice sheets, to maintain the flow of water at the right amount and in the right locality for power purposes. That is one of the largest problems on the St. Lawrence River.

You can see, I think, from what I have said some of the difficulties that occur, with discharges which vary in the winter time from 180,000 to 220,000 cubic feet per second, and with variable temperatures which vary from 30 below zero to 50 above zero, with alternating formation of new ice and then a cessation, then a thaw, then a formation again of new ice, one formation on top of the other. The difficulties accumulate exceedingly rapidly. That is the cause of the great ice jams that have occurred at various places on the St. Lawrence River, some below Morrisburg and the more serious ones below Montreal.

Now, I want to show you several things about ice on the slides. There are those hanging dams, of which I spoke. It was found that the water area varied between 55,000 and 70,000 square feet, which at 3 feet a second is just about 180,000 to 190,000 cubic feet per second. And there you come back to this curious fact of 3 feet per second velocity which enables the ice to form itself into a hanging wall.

Plans of Development

We will now come to the description of the plans of development as worked out by the Joint Board of Engineers and as contained and described in this report. I will put on various slides and endeavor to describe the principal schemes.

You have heard of a difference of opinion with reference to the method of developing the International section of the river. Alternate plans were recommended by the United States and Canadian sections of the Board. These differences will still have to be adjusted before any part of the project can be proceeded with in this portion of the river.

The U.S. Engineers favored a single stage plan with a main dam at the foot of the Long Sault Rapids at Barnhart Island, just above Cornwall, as I show on this slide. This would raise the water to the full height of about 85 feet up to the level of Lake Ontario at this one point and would provide for the generation of all the power in one large double power house—one for Canada and one for the U.S.—generating a total of over 2,200,000 H.P. The navigation canal here would pass around on the United States side a distance of from four to six miles, depending on details, and would have three locks. Such a plan would flood a great deal of land and would concentrate the fall and the control of the river in a single place, thus bringing Lake Ontario level down nearly to Cornwall.

The Canadian Engineers favored a double stage plan with an upper power station at either Ogden Island above Morrisburg or at

Chrysler Island seven miles below that place. The upper station, if at Chrysler Island, would produce under about 30 feet head a total of about 600,000 H.P. in two stations, one on each side of the river. The lower stations also, at Barnhart Island, would, under the remaining 55 feet, produce about 1,600,000 H.P. total. The navigation canals in either case are proposed to go around on the U.S. side as in the single stage plan.

The Canadians maintained that the double stage scheme, while not providing quite so much power as the single, had the advantage of not flooding so much land along the river, and being in two stages was easier to finance, when considering the slower rate at which Canada could absorb the power. This double scheme had also an important advantage in its method of the control of the flow of the river higher up, when coming out of Lake Ontario level and thus being capable of minimising fluctuations of the river levels in the lower or Canadian reaches of the river and in Montreal Harbour. The principle to which the Canadian Engineers adhered was that there could be a more uniform rate of flow secured at a point far removed up stream from the main or larger power station.

With respect to estimates of cost, the International section under the Canadian plan, providing for 27 feet depth for navigation and securing about 2,200,000 H.P. total for both countries, is estimated from the figures in the Report, to be about $273,000,000. Of this, about $88,000,000 might, on reasonable assumptions, be considered to be for navigation purposes.

We now come to the National or wholly Canadian portions of the river, below Cornwall. These carry the canal on down through Lake St. Francis, into the section known as the Soulanges, comprising the Coteau, Cedars and Cascades Rapids and then into Lake St. Louis, then down the Lachine Rapids to Montreal. These portions comprise a total distance of about 65 miles with an aggregate fall of about 135 feet.

By the slides I show of the Soulanges region, you will observe that the proposal is to have the navigation canal on the north side between the two lakes. The navigation and the several power plants are proposed to utilize the total fall of 85 feet by means of dams and power houses in successive stages. This plan embraces the continued use of the present 200,000 H.P. Cedars plant. This entire locality being wholly in Canada, work could proceed if desired, without any preliminary international agreements. It is about this part that the recent discussion has occurred regarding the franchise for a private corporation, the Beauharnois Company, to develop power by a canal on the south side of the river forming a long head-race of about 15 miles.

The Lachine Rapids just above Montreal will under the plans submitted be flooded out by means of a dam at the lower end several miles above the Victoria Bridge and the navigation canal would pass down the north side in the western suburbs of Montreal.

The whole capabilities of the National or Canadian portion of the river comprising these two regions would be about 2,800,000 H.P. when fully developed. The Engineer Board, however, provided for an initial power development of only about 400,000 H.P., this being at the Soulanges. Such a plan and providing for 27 ft. depth for navigation would, according to the published estimates, cost about $161,000,000. Of this about $106,000,000 would be for navigation, on reasonable assumptions.

Preliminaries to Construction

That gives, in a general way, the idea of the St. Lawrence scheme for navigation and power, and, just in closing, I want to speak again about the difficulties in dealing with these general conditions that have to be met with. There are just one or two things that I would like to speak of.

You have heard a great deal about the power business, and I think it is the very general idea of the people of our own country that no power should be exported from Canada to the United States, that is, no Canadian-made power. This is very sound from an industrial point of view.

Another thing is, and you can readily see it, that Canada cannot very well deal with this project, so far as Ontario is concerned, that is, the international or upper end of it, without dealing with the United States. They are our neighbours. The river is a boundary between the two, and under international law or any other kind of law, Canada cannot raise the level of the river at any part without getting the consent of the neighbour who is on the other side of the river. And you have seen how it is well nigh impossible to proceed economically with a project like this through wholly Canadian territory. It is too expensive, as I have shown you. The natural thing to do is to build it by means of some arrangement with our neighbours, so far as the International portion is concerned. I want to point that out, because there is a good deal of talk going around nowadays, with many people wondering why we have to deal with the United States at all. It is quite obvious that the project in its entirety could not very well be undertaken otherwise.

There have, however, been some suggestions recently to start the development of the project from the lower end up, and there may be something arise out of that. Undoubtedly, as far as Canada is concerned, power can be developed down in the Quebec portion without asking any questions of our neighbours. Whether Canada can afford to build and pay for the whole of the navigation in its own country is another question, particularly as it is carrying on the new Welland Canal with its $115,000,000 as the ultimate cost.

In conclusion, I feel that I have taken more time than I should have at some parts of this address and perhaps gone over other portions too quickly, but it is such a large thing and there are so many features of it where you are interested not only as engineers but as citizens, that it is hard to distinguish between the general side, the technical, and the economical and financial.

The Corrosion of Metals

A Thesis for the Degree of B.A.Sc.

By A. R. Battye, 1927-28

The corrosion of metals, particularly that of ferrous metals, has now become a matter of great importance in the engineering world. This is due largely to the enormous increase in the quantity of iron and steel articles now manufactured, resulting in a great amount of wastage. Some economists and financiers regard this wastage as a serious source of inefficiency in itself, while others consider that the rapid depletion of the ore supplies is a further reason why corrosion should be prevented.

Corrosion may be defined broadly as the chemical action of certain agencies on metals causing their deterioration and ultimate destruction. Metals thus tend to revert to more stable combinations of which the metallic ores, as found in nature, are familiar examples. Under normal conditions, such as corrosion in the presence of moisture, the products consist mainly of Hydroxides. In practice many factors influence corrosion and consequently many explanatory theories have been evolved. Each of these theories refers to some particular factor as being the principal agent in corrosion. The electrochemical theory is, however, most widely accepted at the present time, as this theory accounts for practically all the observed facts either in some broadened or modified form.

The basis of the electrochemical theory is that iron, like all other elements, has a definite inherent tendency to go into solution when placed in water, and in so doing displaces some other element already in solution. In the ordinary case, when iron is placed in water, Hydrogen is the element displaced. This Hydrogen gathers on the surface of the iron in the form of a thin invisible film which may prevent further reaction by insulating the metal from further solution. If, however, the Hydrogen is removed, either by combining with the dissolved oxygen in the water, or else by escaping as gaseous Hydrogen due to motion of the water, the reaction will continue.

TABLE I

Solution Potentials of the Elements or Electrochemical Series.

Element	Valence of Element Insol.	Potential in Volts
Potassium	1	−2.9
Sodium	1	−2.9
Calcium	2	−2.6
Magnesium	2	−1.6
Manganese	2	−1.08
Zinc	2	−0.76
Iron	2	−0.43
Cadmium	2	−0.40
Nickel	2	−0.22

Lead	2	−0.12
Tin	2	−0.10
Iron	3	−0.04
Hydrogen	1	0.00
Copper (Cupric)	2	+0.34
Antimony	3	+0.47
Copper (Cuprous)	1	+0.51
Mercury	2	+0.80
Silver	1	+0.80
Platinum	4	+0.86
Gold	3	+1.08

The Hydrogen Potential is arbitrarily taken as Zero.

In most cases the iron which goes into solution is immediately thrown down as rust, and this together with insoluble material from the water forms a coating on the surface of the metal. This coating sometimes insulates the metal from the solution and prevents further corrosion.

When a metal goes into solution it does so with the formation of ions. This tendency is called "the metal potential" and is the inherent force which sends metal ions into solution thus causing and helping to maintain corrosion. This metal potential may be influenced by the condition of the solution. For example, if the metal ions already in the corroding solution are in high concentration, they exert a back pressure which opposes further solution of the metal. On the other hand, in acidified waters, where the Hydrogen ion concentration is high, the production of atomic Hydrogen is assisted, and this nascent Hydrogen bubbles away from the metal, causing more rapid corrosion. The metal potential can be measured. This is done by setting up an electric potential in the opposite direction of such strength as to just prevent the metal from going into solution. Each metal possesses a certain potential, and by arranging them in order the Electrochemical Series is formed. From this series it is usually true to state that one metal will displace from the solution any other metals below it in the series, provided there is no interference from outside reactions.

Hydrogen reacts just like a metal and exerts a back solution pressure that opposes the plating out of more Hydrogen. If therefore the Hydrogen be present as a gas at atmospheric pressure (as in the case when bubbles are given off during corrosion) the solution potential is zero. This is the basis used in the Electrochemical Series. If, however, these bubbles are prevented from escaping the solution pressure will rise and corrosion will cease. Also, if the atomic Hydrogen is oxidised or depolarised by dissolved oxygen in solution, the solution potential will fall below zero and corrosion will be accelerated.

The electrochemical theory was first applied to corrosion by Whitney in 1903.[1] He considered that the reaction should be written as—

$$Fe\ (Metal) + 2H^{+}\ (ionic) = Fe^{++} ionic + 2\ H\ atomic.$$

Some years later Walker[2] demonstrated another reaction which took place when corrosion continued, that is when the polarising or insulating film of Hydrogen on the surface of the metal was removed. The removal of Hydrogen was written as

2 (*a*) 2 H Atomic + ½ O_2 dissolved = H_2O liquid water
(*b*) 2 H Atomic = H_2 Molecular

These two reactions may occur either simultaneously or separately. Investigations by the Massachusetts Institute of Technology and National Tube Co., and also other practical observations indicate that the amount of Hydrogen produced by corrosion of iron in neutral or alkaline waters is small compared with the amount of Hydrogen removed by oxidation. It is therefore evident that oxidation of Hydrogen accounts for the progress of the reaction and must govern the rate of corrosion. In the case of iron in natural waters, there is also the oxidation of ferrous to ferric iron. In the case of non-ferrous metals that are below Hydrogen in the electrochemical series, Hydrogen is deposited on the metal but not in sufficient quantities to cause evolution of the gas. Corrosion therefore follows reaction 2*a* in this case. This reaction is exemplified in the case of copper which does not corrode in the absence of oxidizing agents even if acid solutions be employed. The effect of Hydrogen ion concentration on the rate of corrosion is shown in Fig. 1. The Three Zones represented here are the alkaline zone (left), the neutral zone (centre), and the acid zone (right).

In the alkaline zone, reaction (1) takes place together with reaction (2*a*) but as the Hydrogen ion concentration decreases, the

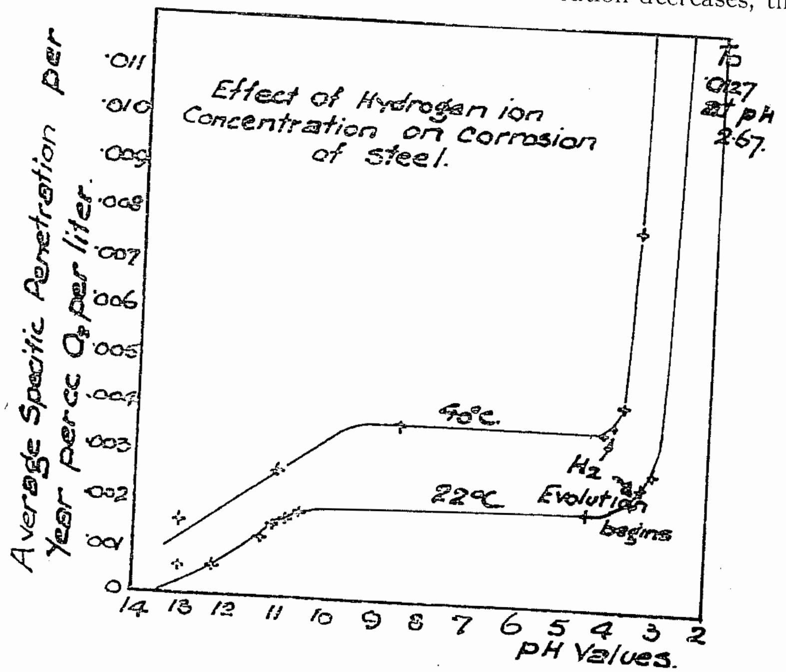


Fig. 1

action slows down. Theoretical and practical evidence indicate that reaction (1) predominates under all conditions. It is also common knowledge that the chief cause of slowing down of corrosion is the rust coating which is very protective against alkaline solutions. In the neutral zone, reaction (2*a*) is the dominant factor because, unless this reaction can proceed, the retention of the polarising Hydrogen film on the surface of the metal forces reaction (1) to cease. The rate of diffusion of dissolved oxygen to the metal surface, therefore, controls the rate of corrosion. Agitation of the solution will therefore cause rapid corrosion since it increases the rate at which the dissolved oxygen reaches the metal surface. Difference of temperature in the solution will also increase this tendency as it causes convection currents. Within the limits of neutral waters and at normal temperature, variations of acidity or alkalinity have little effect on the rate of corrosion, but if certain salts are added above this they affect the oxygen solubility as well as the protective properties of the rust coating.[3] In the Acid Zone reaction (2*b*) is important since, as Hydrogen ion concentration increases, the effect of the dissolved oxygen becomes less. Surface finish, velocity of motion and temperature exert considerable influence in this case.

Until the electrochemical theory was evolved no good reasons existed to account for the action of two metals in contact. It was found that when two metals were brought in contact, corrosion was generally stimulated unless protective measures were taken.

When a metal such as iron, which is above Hydrogen in the Electrochemical Series, and does not quickly form a protective coating, comes into contact with a more cathodic material, it plates out a film of nascent Hydrogen on the cathode or material lower in the Electrochemical Series. This causes a flow of current from the iron through the solution towards the cathode, at the same time causing the iron to dissolve. The concentration of this Hydrogen film will depend on the rate of oxidation which in turn will depend on the electrical resistance of the solution. If this film is far from the anode, where the metal is dissolving, the film will be oxidized at a greater rate than that of deposition. The effective distance in pure waters is a fraction of an inch, but in solutions of higher conductivity, such as sea water, it may amount to a foot.

The tendency to plate out Hydrogen will depend on (1) the driving force or e.m.f. developed by the solution pressure of the metal dissolving, (2) the conductivity of the solution, (3) the rate of removal of the Hydrogen. In the case of iron in contact with zinc (which is an anodic element, since it is above iron in the Electrochemical Series) the Hydrogen film is plated on the iron (which does not dissolve) by solution of the zinc. Thus iron may be protected by destruction of the zinc.

In either case the rate of corrosion will depend on the total amount of dissolved oxygen which reaches the total area covered by the Hydrogen film. Also the loss in weight will be concentrated on the anodic portions of the surface.

This theory now explains pitting which is the most common cause of failure in pipes. It is usually due to a particle of mill scale left on the surface of the pipe. This mill scale or magnetic iron oxide $Fe_3 O_4$ is cathodic to iron, with the result that the iron, being the anode, dissolves under it. A similar reaction takes place in an iron pipe almost completely covered with lead except for a small scratch. At this point the anode iron dissolves at a rate depending on the area of the inert surface that it can keep saturated with Hydrogen. Pitting is therefore merely a localizing of all the corrosion that can take place inside an anodic area which, if small, may in a short time cause the destruction of a large body whose remaining surface is free from attack. Oxygen and similar factors determine the amount of corrosion but the localizing factors only determine its distribution.

In quite recent tests of Smith & Shipley,[4] corrosion was found to take place when a metal was in contact with two solutions of the same salt but of different concentrations. In this case the more dilute solution was the anode.

Experiments made by Evans[5] also indicate that localized corrosion is caused when any area of metal is in some way shielded from excess of oxygen in solution. He found that the shielded area became anodic. In this connection he states:— "Suppose that a small cavity exists on the surface of the metal into which oxygen cannot diffuse quickly. A current will be produced between the unaerated area within the cavity which will become anodic and the aerated part of the surface outside which will be the cathode . . . Since the rate of attack is determined by the supply of oxygen to the whole surface outside the pit, and since it is all concentrated on the small area within the pit, the rate at which corrosion bores into the pit will be very great and perforation of the article may occur at this one point before any appreciable thinning at other parts of the surface." These facts explain pitting which often occurs in metals that are practically pure and homogeneous;[6] they also indicate that certain controlling factors external to the metal determine the localization of corrosion rather than variations in the metal itself.

Corrosion[7] quite recently has been found to take place in neutral and alkaline waters with the production of Hydrogen gas but in the absence of oxygen. This seems contradictory to past statements but is quite in keeping with the Electrochemical theory. Whitman explains it as follows:— "In the presence of dissolved oxygen a film of ferrous rust is maintained against the metal and is sufficiently soluble to keep the thin liquid film on the metal surface somewhat alkaline thus repressing the tendency to evolve hydrogen gas. In the absence of oxygen, however, this alkalinity of the liquid film is not necessarily maintained because corrosion is much less rapid and the alkali which is produced has a chance to diffuse away. Under these conditions, therefore, the alkalinity of the film is less, the tendency for the Hydrogen gas evolution is increased and the Hydrogen can be evolved in appreciable amounts."

If the oxygen-free liquid flows over the metal, the molecular Hydrogen formed is carried away and corrosion is rapid.

Internal Factors Influencing Corrosion

From what has already been written, it can be seen that a metal which possesses a low solution pressure and forms a self protective

coating with the products of the reaction should be highly resistant to corrosion. No low priced metal with these qualities as yet has been produced. It is also clear that the methods of manufacture of the material are less important than the external conditions to which the metal is subjected. Manufacturing is influenced, however, to a certain extent, by the external conditions. For instance, in the atmosphere it has been found that copper bearing steel[8] is highly resistant to corrosion but in water it is not so good. Certain ferrous alloys have also been discovered that are very resistant to corrosion. Friend, Bentley & West[9] have shown that Nickel alloys containing from 3 to 26% nickel are very resistant to corrosion in water and air, while Diegal found excellent results in his tests with sea water.

TABLE II

Analysis of Atha's 2600 Chrom. Nickel Sil. Steel

Element	%
Carbon, variable, not over	0.50
Manganese	0.70
Silicon	1.75
Chromium	8.00
Nickel	22.00
Copper	1.00

This alloy can be hot forged, and welded by fusion.

Chromium alloys with iron and steel containing about 13%[10] Chromium alloys are also very resistant to corrosion. These alloys are the so-called "Stainless" Iron and Steels which preserve a fine polished lustre for a long time. They can be readily rolled or forged at moderate cost and have the unique property of being unattacked by nitric acid.

Nickel Chromium alloys of iron have excellent resistance to corrosion by natural agencies, as well as exceptional resistance to oxidation by heat. They have an advantage over other alloys in that they need not be heat treated or polish finished to give good results. They can be cast or forged and retain a greater proportion of their normal strength at high temperature than other ferrous metals. They are, however, more costly to produce and therefore are used where the highest resistance to corrosion is necessary. The analysis of a highly resistant alloy is given in Table II. This composition was patented by Johnson. Irons and steels containing different quantities of carbon vary in resistance to corrosion. An approximate idea of the relative rating of different metals is given in Table III.

These alloys, with the greater use of copper bearing steels for certain purposes, constitute the most important metallurgical development in the production of ferrous metals resistant to corrosion.

TABLE III

RELATIVE RATING OF METALS

Class of Material	Average Composition					Particularly applicable to			Acids (moderate concentration, 5-15%)					Alkalies, 1-20%	Salts medium concentration			Mine Water	Sea Water	Pure Water	CO_2 Water	Press. Stills in Oil Refineries	Max. temp. for cont. oper. in air		Sea Air	Industrial Atmosphere
	C	Cr	Ni	Si	Cu	Corrosive Condition	Oxidizing Heat	Electrical resistance	HCl	H_2SO_4	HNO_3	Acetic acid	Fruit acids		NH_4Cl	$MgCl_2$	$MgSO_4$						°F	°C		
Low-carbon steel or wrought iron.....	0.10	..	..	..	Trace	..	..	..	P	P	P	P	P	E	P	F	F	P	F	P	E	P	797	428	P	P
Low-car. cop. steel..	0.10	..	..	..	0.25	..	..	..	P	F	P	P	P	E	P	F	F	F	F	P	F	P	797	425	F	F
Grey cast iron......	(2.5 Graphitic) (1.2 Combined)			..	..	..	..	..	P	P	P	P	P	E	P	P	P	F	F	P	F	F	807	375	F	G
Low nickel steel....	0.18	..	3.00	..	..	..	..	..	P	P	P	P	P	E	P	F	F	..	F	P	..	..	842	450	F	F
High nickel steel....	0.30	..	28.00	..	..	..		...	F	G	P	P	F	E	F	E	E	..	E	F	..	..	932	500	G	G
High-silicon iron....	0.60	..	..	14.25	..		..	...	F	E	E	G	G	(E) (P)	E	E	E	G	E	E	E	..	..	..	E	E
Chromium steel:																										
Low carbon......	0.10	13.00	..	..	..				P	P	G	G	G	E	F	G	G	F	G	E	E	E	1112	600	G	G
Med. car. (Ht. tr'd).	0.30	13.00	..	..	..			...	P	P	G	G	E	E	F	G	G	G	G	E	E	..	1112	600	E	G
High Car. (Ht. tr'd).	0.60	13.00	..	..	..			...	P	P	G	F	E	..	F	G	G	G	G	..	E	..	1112	600	G	G
High Chromium....	0.18	26.00	..	..	..				P	P	E	G	E	E	F	..	E	E	E	E	E	E	2012	1100	E	E
Chrom.-Cp. iron...	0.30	20.00	..	..	1.00				P	F	E	E	E	E	F	G	G	E	E	E	E	..	1832	1000	E	E
Chrom-nickel iron..	0.30	5.00	30.00	..	..				P	F	F	G	–	E	..	..	..	..	F	..	..	..	..	..	F	G
Chrom-Ni.-Si. iron..	0.25	18.00	25.00	..	..				F	G	E	E	E	E	E	..	E	E	E	E	E	..	1652	900	E	E
	0.20	26.00	24.00	2.75	..			...	F	G	E	E	E	E	E	..	E	E	E	E	E	..	2012	1100	E	E
	0.45	7.50	20.00	2.75	..			...	F	G	G	F	G	E	..	..	F	G	E	E	G	..	1292	700	G	G
Ch.Ni.Si.Cu.Fe.....	0.30	8.00	23.00	1.00	..				F	G	G	F	G	E	E	..	E	E	E	E	G	..	1292	700	G	G
	0.20	12.00	35.00	1.50	1.00			...	F	G	G	F	E	E	..	..	G	E	E	E	E	..	1652	900	E	E
Ch.-Si.-Fe.........	0.40	8.25	..	2.75	0.75		..	...	P	P	E	G	F	G	..	..	..	..	F	F	..	..	1562	850	F	F
	0.07	17.00	..	3.50	..			...	P	P	E	G	E	E	..	..	..	F	E	E	..	..	1472	800	G	E
Calorized Fe........	..	..	..	1.25	..	..		...	.	.	.	.	..	..	..	..	..	P	P	P	..	F	1652	900	P	P
Monel Metal.......	0.15	Mn 1.50	67.50	0.50	28.50		..	...	G	E	P	G	G	E	E	E	E	P-E	E	E	E	F	1472	800	E	F
(Monel-Metal for comparison)																										

G = Good; E = Excellent; F = Fair; P = Poor.

EXTERNAL FACTORS INFLUENCING CORROSION

Compared with the external factors influencing corrosion the internal factors just mentioned exert little influence on the rate of corrosion. This rate, as has already been explained, depends mainly on the rate at which the dissolved oxygen reaches the metal surface, and this in turn is controlled entirely by the external influences to which the metal is subjected.

For corrosion in the atmosphere, the chief essential is moisture. Witness the Delhi pillar which is comparatively free from corrosion chiefly due to the dry climatic conditions. Another essential is, of course, a means of transmitting the oxygen from the air to the metal surface either by solution, convection or diffusion. Temperature therefore exerts certain influences, since it causes convection currents and decreases viscosity both of which increase the amount of oxygen which can diffuse. Motion of the solution or air agitation has already been mentioned. Pressure above the liquid increases solubility of oxygen while humidity above the liquid decreases solubility. Protective films and coatings have already been discussed as a means of preventing oxygen from reaching the metal surface. Dissolved substances in the corroding solution, whether they be gases, acids, alkalies, salts, or organic and bacteriological material, may also influence the rate of solution, as also may the rate of diffusion and convection of the dissolved oxygen. Depth of immersion especially in unagitated solutions affects convection currents and therefore influences the oxygen transfer. The area of corroding solution exposed to the air influences the amount of gaseous oxygen which will dissolve in unit time. This amount is also directly proportional to the area exposed. If the surface area of the solution is decreased the amount of corrosion will be reduced.

In the case of natural waters, substances in the air affect corrosion since they are the first to be absorbed in the formation of the solution. Inert gases, for example, tend to reduce corrosion as they displace oxygen in solution. Carbon dioxide is always present in the atmosphere and is consequently nearly always present in water. This is the basis of the acid theory of corrosion. Carbon dioxide, with water, forms a weak acid which, like all acids, stimulates corrosion. The chief effect in this case, however, is to influence the solubility of calcium and magnesium carbonates which form a protective coating in natural waters. The carbon dioxide dissolves these coatings and consequently accelerates corrosion. The reaction may be written as follows: –

$$Ca\,Co_3 + Co_2 + H_2O = Ca\,(H\,Co)_2$$

Insoluble Soluble

Hydrogen Sulphide is a great corrosion stimulant since in water it forms an acid which corrodes rapidly even in the absence of oxygen. It is usually found in peaty soils, sewage and mineral waters. With large quantities of oxygen it forms sulphuric acid which causes rapid corrosion, while in the absence of oxygen sulphides of iron and sulphur are produced. These products are both cathodic to iron, thus causing localized corrosion by increasing the cathode area available for depolarization of nascent Hydrogen.

Chlorine has a similar action producing acidity of the water, and Hypochlorous acid, which is a good depolarizer. The reaction is:

$$Cl_2 + H_2O = HCl + HOCl$$

Organic matter and bacteriological organisms tend to reduce corrosion as they absorb oxygen from the solution. There are certain external factors which influence the localization of corrosion and form pitting. The most common are dissimilar metals in contact and concentration cells, both of which have been discussed. Water line corrosion is often found in service and usually results in accelerated attack at or near the water line. Watson and Watts explain it as due to the downward flow of heavier solution containing the products of corrosion which is partly exhausted of free oxygen. At the same time a fresh and more active solution is brought in contact with the metal at the water line. The electrical conductivity also is an important factor. In a circuit formed when a metal is immersed in solution, the metal itself is very conductive, and it is the remaining section consisting of the corroding solution which determines the conductivity. The area which the anode keeps covered with Hydrogen depends on the conductivity, hence the rate of corrosion is affected.

Strained metal when in contact with unstrained, is found to become anodic and causes corrosion. This is often found round rivet holes where the metal corrodes and fails quite rapidly.

Stray current electrolysis also causes localized corrosion at points where such currents leave a metallic structure which is in contact with water or moist soil. Pipes situated near electric railways have been quite noticeably affected in this way.

There are certain other factors influencing corrosion, that are of a slightly different nature to those already mentioned.[11] Light, for example, has been found to accelerate corrosion. This is probably due to local heating effects which produce convection currents. Duration of exposure of metals undergoing corrosion is another factor. The initial rate of corrosion is usually much greater than after a state of equilibrium has been maintained. This is nearly always due to corrosion products collecting on the metal surface and acting as a protective coating.

Passivity is a property of metals for becoming abnormally inactive toward certain chemicals. It may be produced by immersing the metal either in strong nitric acid, chromic acid or in solutions of chromates or else by making the metal anodic in an electrolytic cell. This alters the position of the metal in the Electrochemical Series and its effects may last for a considerable length of time, but never permanently.

Busy metal or one subject to repeated cold rolling and vibrating corrodes more slowly than metals not in use. Witness rails continually in use as compared to those on a siding.

Steam at high temperatures is found to attack iron or steel

quite readily, producing magnetic oxide of iron according to the equation

$$3\ Fe + 4\ H_2O = Fe_3O_4 + 4\ H_2$$

This causes great destructive effects which are important in large steam power plants. Chromium, nickel, and nickel chromium alloys of iron are found to be more resistant than ordinary irons and steels.

High temperature oxidation is mainly due to direct chemical combination of oxygen with the metal. Some metals, such as magnesium and calcium (light and low melting point metals), form oxides having a porous and non-protective structure, while others such as nickel, chromium, aluminium and iron form a continuous protective oxide.

Prevention of Corrosion on Surfaces Exposed to Atmosphere

Prevention of corrosion is dependent on the conditions under which corrosion is taking place. Near big industrial centres, for example, the atmosphere contains considerable quantities of hydrogen sulphide and particles of foreign matter which come in contact with the metal and cause corrosion in the manner already explained. Suitable protective coatings, produced either naturally or by some artificial means, are therefore necessary.

In the air some metals, such as zinc, aluminium, nickel, copper, also steels carrying small amounts of copper, form a good natural protective coating. Old wrought iron articles have been found in a good state of preservation, *e.g.*, the Delhi pillar. In these cases a protective film of oxide was found next to the metal surface. This protective natural film of oxide can only be formed in a hot dry season.

No permanent remedy for atmospheric corrosion of iron has as yet been found. Artificial coatings which protect the metal from the corroding medium have therefore been applied from time to time. These coatings are divided into two main classes, *viz.*, metallic and non-metallic.

The most widely used of the non-metallic coatings are paints. Generally speaking, these are made up of more or less insoluble particles of pigment suspended in some sort of a continuous vehicle which is usually an oil that dries on exposure to air. The study of paints has become so involved in recent years that it is now regarded as a separate subject. Table IV indicates in their rating order different paints investigated in a recent test at Atlantic City.[12]

Other non-metallic coatings are produced by heating the iron in various media, depending on the color or character of the coating desired. For example, in the Buffington process, a fine black oxide coating is produced by dipping clean iron in a melted mixture of potassium nitrate and manganese dioxide, at a temperature of 660°F. Similar methods are used in blueing, blacking, and browning, different chemicals being used in each case.[13] Phosphate coatings are often used. The most common process is the Parker process,

TABLE IV

Formula No.	Composition of Paint	Rating 1914
34	American Vermilion (Basic Chromate of lead)	
5	Sublimed blue lead	7.5
111	Burnt umber, 60%; Zinc lead, 20%; Zinc & barium chromate, 20%	6
555	Lampblack 40%; Graphite 40%; Barytes 20%	5.5
21	Carbon black and barytes	5.5
41	Chrome green	5
666	Red oxide of iron, 50%; carbon black, 5%; barytes, 35%; chrome yellow, 10%	5
888	White lead, 20%; barytes, 40%; chrome yellow, 35%; Prussian blue, 5%	5
20	Willow charcoal	5
444	Zinc oxide, 60%; zinc chromate, 15%; silex, 20%; whiting, 2%; Prussian blue, 3%	4.5
10	Red lead—85% Pb_3O_4	4.5
39	Zinc chromate	4
49	Zinc and lead chromate	4
51	Magnetic black oxide	4
16	Natural graphite	4
4	Sublimed white lead	4
36	Medium chrome yellow	3.5
44	Prussian blue	3.5
9	American orange mineral—98% Pb_3O_4	3.5
15	Prince's metallic brown	3
12	Bright red oxide of iron	3
40	Zinc and barium chromate	2.5
100	Carbon black	2.5
14	Venetian red	2
24	French yellow ocher	1.5
17	Artificial graphite	1.5
19	Lampblack and barytes	0
90	Lampblack	0
5555	Coal-tar composition	0
		0

in which the iron, after cleaning, is dipped in a boiling solution of Phosphoric Acid and Phosphates of ferrous and ferric iron. Concrete Bituminous coatings (ordinary coal tar or pitch) and slushing compounds (iron drying compounds of a petroleum grease base) are also used.

In the case of metallic coatings the property of being anodic or cathodic to the base metal is more important than in the case of the non-metallic, since the relative potential difference between the metals is much greater. Cathodic metallic coatings such as those produced by tin, lead, copper, are undesirable as they accelerate corrosion if the coating should by chance possess pin holes or scratches. Metals anodic to iron are therefore used although they are less durable in themselves. Zinc is the most widely used for commercial purposes. The zinc, being anodic to iron, corrodes first, but in doing so it forms a closely adhering resistant film that is not attacked, and further rapid corrosion is prevented. In the atmosphere, this film usually consists of zinc carbonate or basic carbonate, whereas under water, zinc hydroxide is most common. The usual method of applying this coating is by galvanizing, the iron being previously cleaned and dipped into molten zinc. Another method

is by sherardizing where the iron is placed in zinc dust inside a drum at a temperature of about 700°F and is slowly rotated. A resistant film is formed that is black in color. The coating may also be applied by electroplating or spraying.

Aluminium is a metal also slightly anodic to iron, but as soon as the coating is formed, it becomes neutral. It is applied by "calorizing" by a process very similar to sherardizing in the case of zinc. The temperature in this case should be about 1740°F.

Cadmium stands between zinc and aluminium with respect to its protective properties. It is usually electroplated or sprayed on to the iron. Its high cost prevents this metal from being widely used.

Lead, tin and their alloys are sometimes used in spite of their cathodic properties. Tin and terne plate are usually applied by the hot dip process which is similar to galvanizing, but to protect the metal against pin holes and scratches, a layer of red lead paint is applied to the metal surface. Lead is usually electroplated on the iron. Copper and nickel are both cathodic to iron and are therefore electroplated to substantial thickness when they form a comparatively durable coating. In both cases the metal should be cleaned before electroplating. Copper may also be sprayed.

Chromium,[14] when electroplated on iron, has the same properties as the chromium iron alloys. It is harder and whiter than nickel and is also anodic to iron. It has also been applied by chromizing[15] which is similar to sherardizing. This is quite a recent development.

Prevention of Corrosion under Water

In corrosion under water, a greater combination of factors influences the means of prevention. The properties of the solution in which the metal is immersed, those of the metal itself, and also the conditions above the liquid, all exert different effects. Pipes and containers carrying liquids both come within the category of underwater corrosion. Preventive measures in this case are formed either by artificial preparation of the metal surface, by formation of natural preventive coatings from corrosion products or by treatment of the solution which renders it non-corrosive. Non-metallic coatings are not found satisfactory and therefore metallic coatings are used to a greater extent. Of these coatings, zinc, applied by the galvanizing process is the most common. Lead is little used by itself, on account of its cathodic properties. A lead or tin lining, however, when applied over a clean galvanized surface affords a very good protective coating, thus combining good durability with the strength of steel.

Cement linings are widely used for mine and drainage pipes carrying acid water. These, when the temperature is not great enough to disintegrate the concrete, afford one of the best known means of protection. When the metal surface is clean, the cement adheres well to it but added weight and risk of damage in transit prevent this method from being generally applied. Portland Cement is resistant to many chemicals and is quite widely used in the chemical industry.

Successful attempts have now been made to obtain waters which will produce protective coatings at will. This is done either by causing the liquid to deposit a coating on the metal exposed to it or else by causing the products of corrosion to form a protective coating. These are generally produced by the addition of alkalies or silicates to the water or sometimes even by passifiers.

Alkalinity is due either to Hydroxides or carbonates, the former being the more effective. These Hydroxides, when exposed to air, are changed to carbonate or bicarbonate, and since alkalinity

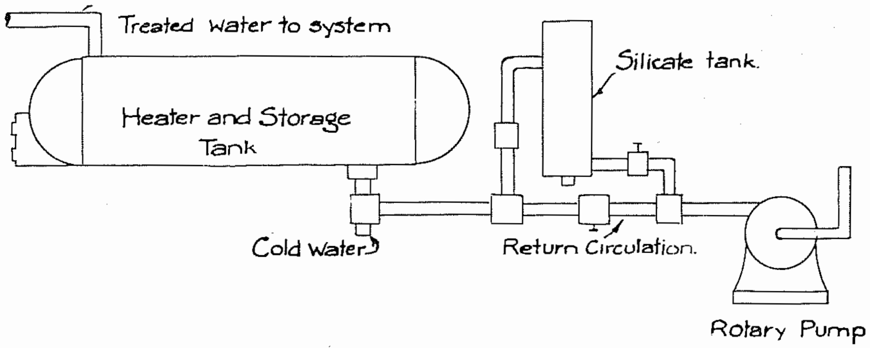


Fig. 2

decreases the rate of corrosion Hydroxide solutions should be protected from the air. In practice, alkalinity due to carbonates is built up by the addition of a lime salt which either builds up or breaks down the carbonate coating on the metal surface according to the reversible equation.

$$Ca\,(H\,Co_3)_2 = Ca\,Co_3 + H_2O + Co_2.$$

Investigation led to the discovery that sodium silicate, when added to water, forms an excellent protective coating on iron. This does not entirely prevent corrosion but lessens it considerably in cold water and even more so in hot. It is therefore quite widely used in hot water supply systems, but in this case it is only effective for 200 feet from the point of application. In cold water this distance is greater. Hence its wide use in domestic water supplies. In hot water systems it is usually added in the solid state in the ratio 3.25 sodium silicate (S_1O_2) to 1 Soda (Na_2O) which is placed in a basket inside a container as shown in Fig. 2.

Sodium bichromate has been found to be a good passifier, that is, it will materially reduce corrosion. It is often used in Hydraulic elevator systems where water is continually stirred up or unduly aerated. It is also frequently used in automatic fire sprinkling systems and condensers where a limited quantity of water is recirculated.

In condensers and refrigerating systems corrosion is prevented by decreasing oxygen concentration to the lowest possible point and raising the alkalinity of solution to a point where corrosion is reduced. In refrigerating systems the use of soda ash is impracticable as calcium carbonate is precipitated from the brine and this clogs the system without giving the desired alkalinity. Calcium and sodium Hydroxides are therefore used for refrigerators while sodium silicate is excellent for condensers.

When corrosion takes place in natural waters that are exposed to the atmosphere, the amount of dissolved oxygen only influences

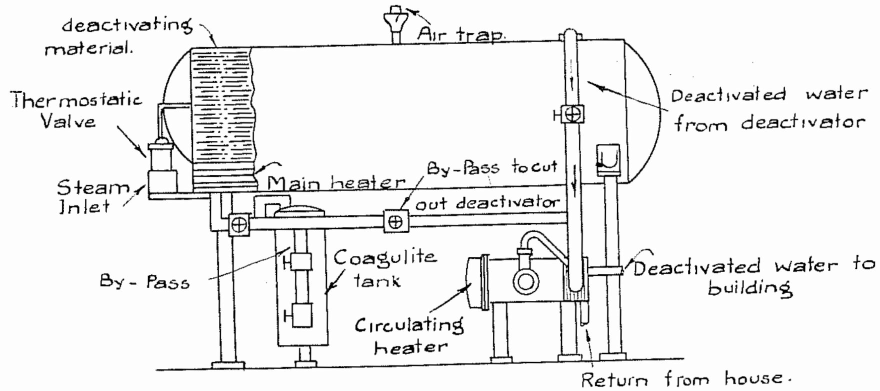


Fig. 3

corrosion while other external agencies control the reactions; but in closed water systems where the oxygen concentration is limited, the dissolved oxygen is the controlling factor. The removal of dissolved oxygen therefore will eliminate nearly all kinds of corrosion from pipe systems. In many closed water systems where these methods already mentioned are insufficient, deactivation or deaeration is employed.

Deactivation is a chemical means of removing oxygen from water by passing it over large surfaces of scrap iron. These pieces of scrap iron rust, and in doing so, remove the oxygen from the water. In recent tests carried out by Speller[16] (who used a deactivator in which steel sheets were employed together with special conditions of temperature, rate of flow, and alkalinity of the deactivating water), the Hydroxides of iron were retained on the sheets, and the water was produced clear and free from corrosive gases. In this way iron is now consumed in a cheap and easily replaceable form in the basement of a building while the more valuable and inaccessible piping elsewhere is preserved.

Deaeration is a mechanical means of removing dissolved oxygen from the liquid. This is done by agitating the water under favorable temperature and pressure conditions when the corrosive gases are

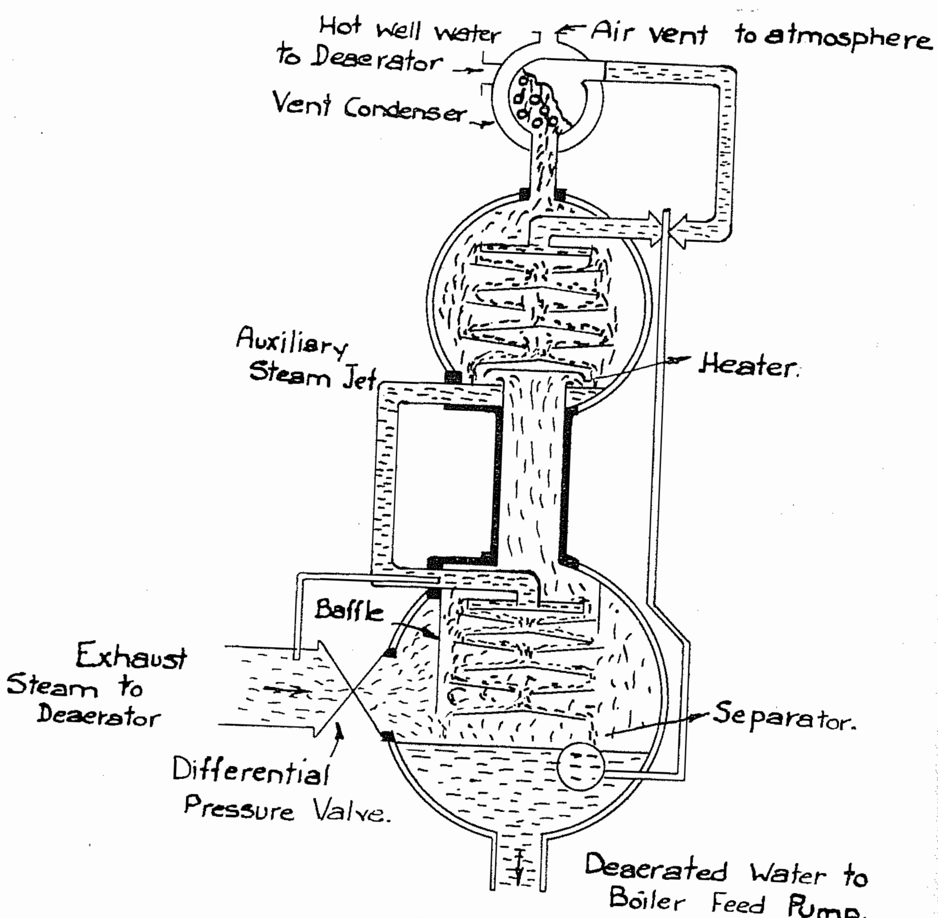


Fig. 4

given off. These gases are then removed by sweeping the water with another harmless gas. A common method is to heat the water under pressure and then lower the pressure on the water causing it to boil rapidly so that the gases are given off. These gases are mostly oxygen, carbon dioxide and nitrogen. Fig. 4 is a diagram of a common type of deaerator in which the steam sweeps over the surface of the heated water. Here the water and current of steam are brought to the same temperature which facilitates complete removal of dissolved gases. The steam then passes up to the heater where it delivers its heat to the incoming water. In this diagram there is no loss of heat as the steam is condensed by the incoming cold water to the heater.

In summarizing, corrosion is a chemical action of an external agency which causes the destruction of metals. This agency is generally water, in which every metal has an inherent tendency to dissolve and plate out Hydrogen. For corrosion to continue, this Hydrogen must be removed, and this is done either by dissolved oxygen or oxidizing material surrounding the metal where the Hydrogen is plated. Therefore, in order to prevent corrosion this Hydrogen must not be removed. All preventive measures are evolved with this fact in view, and the chief means of accomplishing it is by preventing the dissolved oxygen from reaching the point where the Hydrogen is being plated out. On account of the many and varied conditions which influence or cause corrosion the necessary preventive measures are also numerous and the subject is consequently a wide one. But in every known case the electrochemical theory explains the reaction and usually suggests a suitable means of prevention.

References

[1]Whitney, W. R. "Corrosion of Iron", Jour. Am. Chem. Soc. 25, PP. 394-406, 1903.

[2]Walker, W. H., Cederholm, Anna M. and Bent, L. N.
"The corrosion of iron and steel", J. Am. Chem. Soc., pp. 1251-1264, 1907.
"The Function of Oxygen in the corrosion of metals", pp. 473-474, 190.

[3]Whitman, W. G., Russell, R. P. & Davies, G. H. B., "The Solubility of ferrous Hydroxide and its effect upon Corrosion", J. Am. Chem. Soc., pp. 70-79, 1925.

[4]Smith, W. N., Shipley, J. W., "The Self Corrosion of Cast Iron and other Metals in Alkaline Soils"., J. Eng. Inst. Can., pp. 527-535, 1921.

[5]Evans, W. R., "The Electrochemical Character of Corrosion", J. Inst. "Metals", pp. 239-282, 1923.—also "The Newer Electrochemical View of Corrosion of Metals", J. Soc. Chem. Ind., pp. 222-223, 1924.

[6]Bancroft, W. D., "The Electrolytic Theory of Corrosion", J. Physics Chem. pp. 785-871, 1924.

[7]Evans, U. R., "A Paradox in Corrosion", Chem. Met. Eng., pp. 949-953, 1924.

[8]Buck, D. M., "The Influence of very low Percentage of Copper in Retarding the Corrosion of Steel", Proc. Am. Soc. Testing Materials, Pt. 2, pp. 224-237 1919.

[9]Friend, J. N., Bentley, T. L. & West, W. E., "The Corrosion of Nickel Chromium and Nickel Chromium Steel", J. Iron Steel Inst., pp. 249-258, 1912.

[10]Diegel, "Einiges über die Korrosion der Metalle im Seewasser", Verhand. des Ver. Beford Gewerb, 82, 93-152 and 157-186, 1903.

[11]Gibb, C. H., and Arnaud, F. W. F., "On the action of slightly Alkaline Waters on Iron". Analyst, pp. 225-237, 1905, and Friend, J. W., "The Corrosion of iron and steel", Longmans Green & Co., pp. 90, 1911.

[12]Report of Sub-Committee, "On Inspection of Steel Plates at Atlantic City", Proc. Am. Soc. Testing Materials, 14 Pt., 1 pp. 259-260, 1914; 15 Pt. 1 pp. 214-223, 1914.

[13]Speller, F. N., "Corrosion in Pipes, Causes and Prevention", Ch. VIII, pp. 307.

[14]Schwartz, K. W., "Chromium Plating Steel using Chromium Anodes", Trans. Am. Electrochem. Soc., 44 pp. 451-463, 1923.

[15]Kelley, F. C., "Chromizing", Trans. Am. Electrochem. Soc. 43, pp. 351-368, 1923.

[16]Speller, F. N., "A Method for Practical Elimination of Corrosion in Hot Water Supply Pipes", Trans. Am .Soc. Heat. & Vent. Eng. 23, pp. 125-136, 1917.

The Work of the Aeronautical Laboratory of the University of Toronto*

J. H. Parkin, M.E., F.R.Ac.S.

Some ten years ago, the authorities of the University of Toronto, foreseeing the part to be played by air transportation in Canada, and recognizing the importance of research in developing aircraft to suit the conditions in the Dominion, established a laboratory for aerodynamic research. The four foot wind channel of the laboratory was subsequently installed in the Mechanical Building. Research work was commenced in 1919 and has been carried on more or less continuously since that time.

In 1925 the laboratory was moved into a new building, (see Fig. 1) and advantage was taken of the dismantling of the channel at that time to modify its design to enable higher air speeds to be secured than were previously possible.

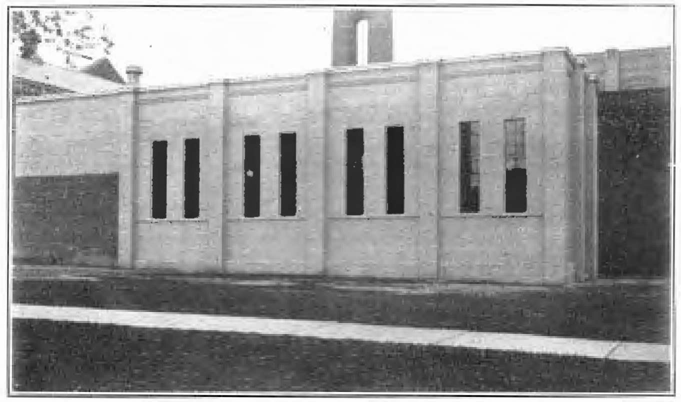


Fig. 1

The new wind channel is of the Royal Aircraft Establishment type (see Fig. 2). It consists of a straight wooden tube, 4 feet square in cross section and some 20 feet long, with door and windows at the experimental section. The air is guided into the tube and the flow straightened by means of a faired bell mouth intake and cellular honeycomb. At the downstream end the air passes into an enlarging trumpet shaped exit cone of doped canvas, in which a gradual transition in section occurs, in some 20 feet, from the 4 feet square section to a 10 ft. diameter circular section in which the propeller rotates. The whole channel is supported in the middle of the building on steel supports.

*Reprinted from *Canadian Engineer*, April, 1928.

The propeller, four bladed, 9′6″ in diameter and 2.75 ft. pitch, is direct connected to a 20 h.p. shunt motor, propeller and motor being supported on a steel bracket quite independently of the channel proper. Motor speed is controlled manually by means of armature and field rheostats, permitting a range in speed from less than 200 to over 700 r.p.m. The motor may be driven from a special constant voltage service.

To suppress the rotation of the propeller slip stream and equalize the return flow of air through the building a cellular wall (see Fig. 2) is built across the building about 10 ft. from the propeller end of the channel. This has proved most effective and in fact has slightly reduced the power consumption of the channel. The channel is particularly efficient, an air speed of 80 feet per second being secured with an expenditure of 25 horsepower at the motor.

The original aerodynamic balance, which carries the models is of the National Physical Laboratory type. In this balance the

Fig. 2

models are supported on a vertical spindle held in a chuck on a vertical arm of the balance projecting through an oil seal in the floor of the channel. The moving element of the balance, (see Fig. 3) consists essentially of three arms mutually at right angles, one vertical, carrying the model, one horizontal and parallel to the channel axis on which the drag is measured, and the third horizontal and normal to the channel axis on which the lifts or cross wind forces are measured. In addition rotation about the vertical axis may be permitted thus enabling torques about this axis to be determined. This balance has proved most useful in the past but its use is limited to low air speeds, since at high speeds difficulties are encountered due to deflections of the supporting spindle. Hence with the increased speeds possible in the new channel, over 80 feet per second instead of the former speeds of 50 feet per second, different balances became necessary.

New balances of the roof or wire suspension type have been designed and constructed at Toronto and have proved very satisfactory in the work so far done with them.

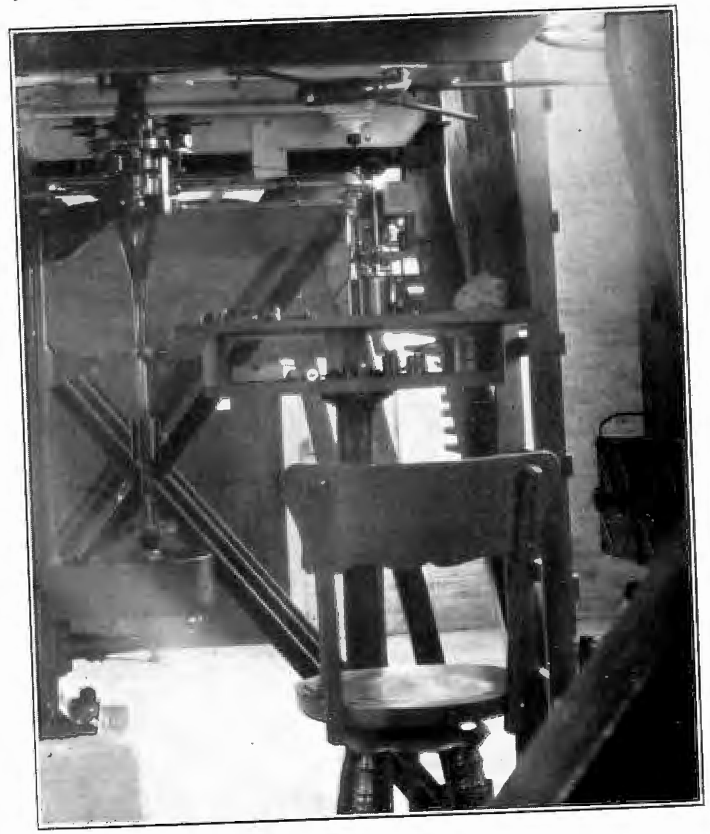


Fig. 3

There are two separate balances carried on steel beams above the experimental section of the channel. The upstream balance, or lift balance, is arranged with a movable beam from which two wires drop through the channel roof to the leading edge of the lower wing of the aeroplane model. The beam may tilt on either of two pairs of pivots at right angles, enabling lifts and rolling moments to be measured. The rear or drag balance is essentially a double balance, a light upper beam measuring lifts and a bell crank lower beam measuring drag. The lift rod and bell crank are connected at

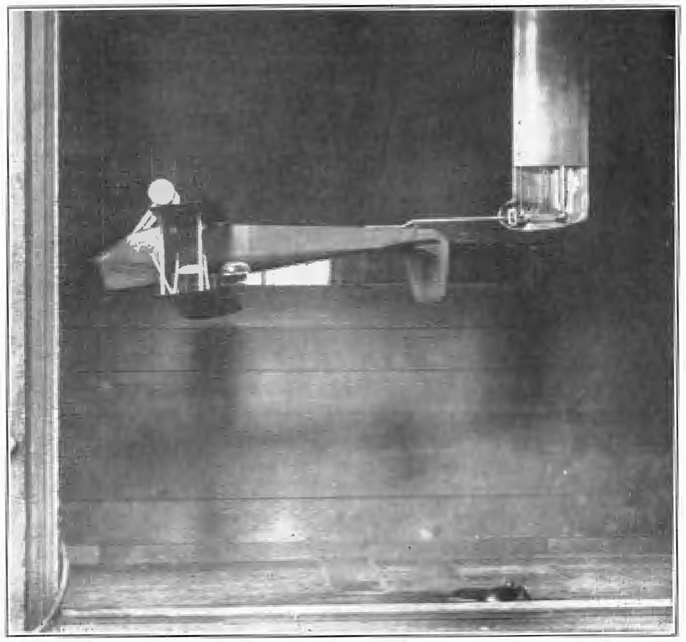


Fig. 4

their lower ends on the channel axis, to each other and to a "sting" from the model, by a completely universal joint or "wobbler". The sting transmits the reaction from the tail of the model to the wobbler from which it is transferred to the balances where the lift and drag components are measured separately.

Incidentally the model is suspended in an inverted position (see Fig. 4) so that lift is downward or negative, exerting tension in the supporting wires and so maintaining them taut. This arrangement of roof balances is distinguished from many balances of this type by the complete absence of obstructions upstream from the model, which would interfere with the air flow past the model.

These balances are most convenient for testing models of complete aircraft, enabling lift, drag, lift/drag, pitching moments and,

if required, rolling moments to be determined with a single setting of the model and, if necessary, by one operation.

The research work of the laboratory has been of two general kinds, one the investigation of problems arising in, or the determination of information required by the aircraft industry; the other the development of improved methods of testing instruments and technique.

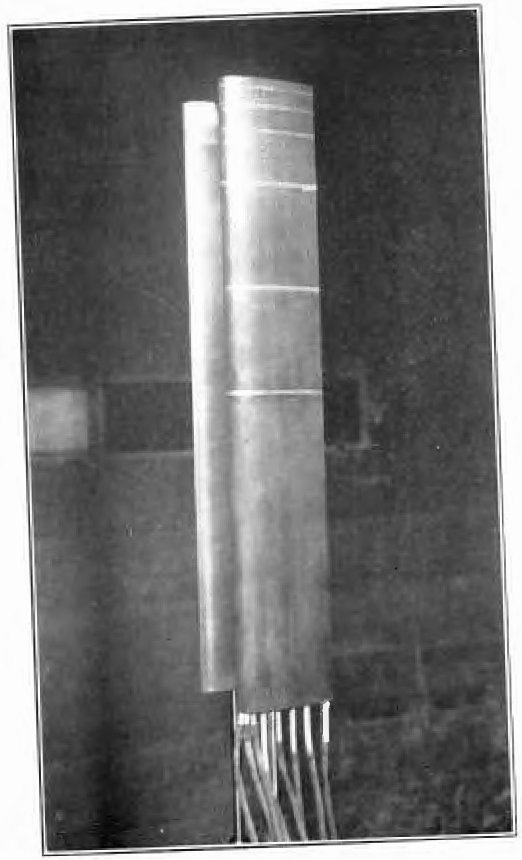


Fig. 5

In the former class investigations have been made of the relative efficiency of different forms of wing tips, of the effect of tapering thick high lift wings, of the downwash in the rear of aeroplane wings, and of the effect of different modifications in the profile of thick wings. The pressure distribution over the surfaces of two widely used wings, alone and in different combinations (see Fig. 5) and the effect of employing thick wings in biplane combinations have also been investigated. Recently, the mutual interference between the wings and fuselage in aircraft was studied.

At the present time an extensive study of the stability of flying boats is about to be undertaken and the effect of skis on aircraft efficiency is to be investigated. Both these problems are of peculiar interest in Canada.

In the second class of research looking to improvements in wind channel technique, studies have been made of air speed indicators, micromanometers, proper form of intake for wind channels, power consumption in wind channels, interference effects of wind channel walls, spindle corrections in wind channel testing and the determination of the centres of pressure of aerofoils.

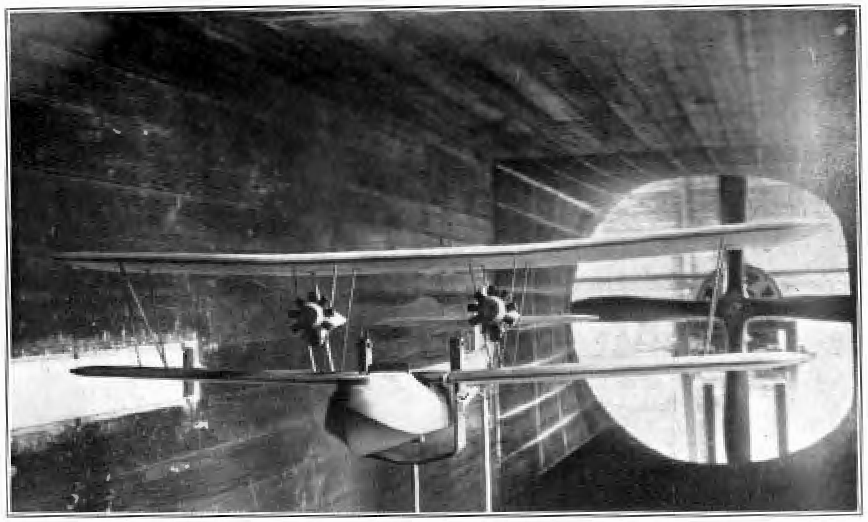


Fig. 6

A research of a somewhat different character, carried out some time ago, was that in connection with the cup anemometer or wind speed indicator, in co-operation with the meteorological service. This study resulted in the development of a new three cup type of anemometer which has been adopted not only by the Canadian Service but also by the American Weather Bureau.

Much of the work done in the laboratory has been carried out in co-operation with the government, and aircraft designers and builders, in the development of new special types of aircraft for Canadian service. The use of the wind channel in this way is analogous to that of the testing tank in naval architecture. A carefully made scale model (see Fig. 6) generally of mahogany, accurate to the thousandth of an inch, and beautifully finished is mounted

on a balance in the channel and from measurements made, the desired information relative to the full scale machine is calculated.

The information required from a wind channel test may be of different kinds.

The commonest model test in the development of a new design is that to measure the aerodynamic characteristics, lift, drag and lift/drag of the machine. From the results of such a test the designer can predict with accuracy the performance characteristic of the full scale machine in free flight.

In some cases the designer may be undecided as to the relative advantages of two or more different wing sections when used on a particular machine. A model is accordingly made and tests run with the different wings and from the results the relative efficiencies of the wings are readily determined.

Frequently the longitudinal stability is the feature to be investigated. The exact prediction, by calculation of the stability of an aircraft of new design is difficult due to uncertainty regarding the mutual interference of the different parts. A wind channel test of a scale model permits the stability to be readily determined. The pitching moments of the model are measured in the wind channel from which the alterations, if any, necessary in the empennage or distribution of weights in the machine can be determined.

In certain machines designed for high speeds the reduction of resistance is of chief importance. In such cases, modifications in the model, are made with plasticene or wax as the tests proceed, which indicate the effects of fairing or other changes and enable the resistance to be reduced to a minimum.

Aerodynamic laboratories have played an extremely important part in the rapid development that has taken place in aircraft; and the laboratory of the University of Toronto, by co-operating to the fullest extent with the government and the industry in the solution of problems arising, has assisted not a little in the development of aviation in Canada.

THE

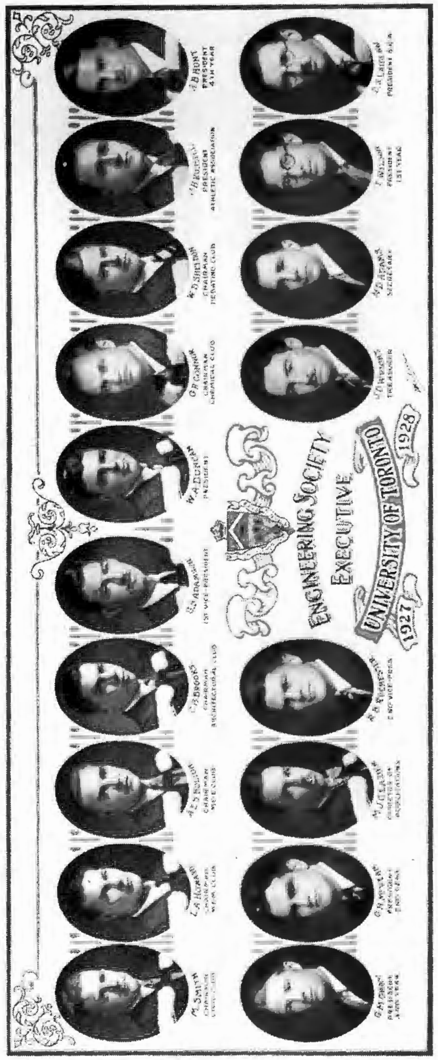
YEAR BOOK

of the

University of Toronto Engineering Society

Faculty of Applied Science

1928



The Semi-Centennial of the Old School

C. H. C. WRIGHT, '88

Early in October, or, to be more exact, on Thursday, Friday, Saturday and Sunday, October 6, 7, 8 and 9th, "School" (Staff, Graduates and Undergraduates) participated enthusiastically in a double-barrelled celebration, viz. the One Hundredth Anniversary of the University of Toronto and the Fiftieth Anniversary of the Faculty of Applied Science and Engineering.

The Council of the Faculty, co-operating with the Alumni and Undergraduates, decided that the 50th Anniversary should be suitably celebrated but not separate from the Centennial celebration of the University; hence, the same dates were selected.

The Alumni arranged for a large reunion of its members and provided for class luncheons, a dance and a banquet, etc., while the Undergraduates held a parade (in conjunction with the general student body) and a Dinner Dance. The energies of the Staff were devoted to assisting in the preparations for the general programme of the Centennial Celebration and provided a buffet luncheon for the Alumni and their lady friends. Thus, all contributed to make the 50th Year Celebration of the Old School a veritable red-letter day in our history, while all blended in to make the 100th birthday of our University unique.

Fifty years of the Faculty of Applied Science and Engineering; 50 years of service to the community: what has it meant? Let any citizen stop for a few minutes and try to consider the difference in conditions. Ask any old timer the difference. To-day we turn a tap and draw an abundance of water for our many needs without considering for a moment that the engineer has provided an intake, a filter, etc., a great pump, a maze of pipe lines and a reservoir to meet this demand—yes, and has given a 24-hour service for 365-1/4 days in the year. This same citizen eats his meals cooked on an electric range supplied by energy from some waterfall possibly many miles away. To harness the mighty Niagara was a problem, the solution of which was not even dreamed of fifty years ago. Electric energy was scarcely known, and to turn the energy of this mighty falls into electric power for the industries in the immediate neighborhood was the first stupendous problem before the graduates of our Alma Mater. Next, to transport this energy for any distance offered difficulties which our engineers were called upon to solve, while to-day the farmer in the remote parts of southern Ontario taps the line and uses this power to thresh the grain, chop the feed, fill the silo, pump the water for the house and stables, as well as do a multitude of other chores without giving any consideration to his opportunities as compared with the oil lantern, the hand pump and the horse power of fifty years ago—

certainly every citizen, no matter what his occupation may be, is enjoying the results of the engineer's efforts of the past 50 years.

To-day the Manager dictates to a machine, his correspondence, and while the office staff is busy placing this, with other machines, on paper, he is in communication with the whole continent over a network of wires. He may even be in touch with vessels crossing the seas on the opposite side of the world without any wire. He may attend a theatre and witness a mechanical production of his favorite play, or sit in his easy chair at home and listen in on the music of the continent. He may drive out in his flivver or his luxurious limousine over a network of magnificent roads such as the world has never seen before. Distance is killed; we are drawn closer together by the engineer in a manner that we too often forget. As one looks carefully over these amazing achievements, he cannot but be struck with the large part played by School graduates, who modestly take their efforts as a part of the day's work.

Fifty years ago Canada was but a narrow strip of land north of Lake Erie and Lake Ontario and along the St. Lawrence River. All else was hinterland and practically unknown. The map was very vague. A few venturesome travellers, the Hudson Bay Co. and the Indians alone knew of it, and they only as a fur-bearing district. No transcontinental railroad; but this small southern strip was populated by a hardy Canadian race of English, Scotch and French extraction, who were seized with the possibilities of this new country and at the same time determined to make Canada something worth while. In an article such as this it is only necessary to ask you to stop and think of this marvellous change. In this connection, do not forget to consider our mineral wealth, the development of our pulp and paper industries. Indeed, to even enumerate the industries whose origin and development in the past fifty years are due to the Engineer,—Civil, Mining, Mechanical Electrical, and Chemical—would be to fill TRANSACTIONS completely.

Before leaving this thought, may I not ask you to compare the homes of 50 years ago with those of to-day. The School buildings, the factories, public buildings, the office buildings, with the modern skyscraper. If you do, I feel that you will be compelled to say that the architectural graduates of S.P.S. in the past 50 years have left their mark too.

Now the Undergraduate body, wishing to mark this history in the parade, were forced to select one line only, and they chose transportation. During the past 50 years transportation in Canada under the direction of the engineer has made many and rapid advancements. Only a few could be demonstrated in such a parade; others could not; for instance, the difference between the small wood-burning locomotive with its big bonnet, snorting up and down hill with a short train of small coaches at an average speed of some 10 miles per hour, to the Modern Mogul hauling in an almost endless train, the commerce of Canada from coast to coast.

The parade of the undergraduates was long and very interesting with the comparisons between the modern truck with those in vogue 50 years ago, the Victoria with the modern range of automobiles.

On Thursday there was a "get together" luncheon at the King Edward Hotel, which was attended by a large number of the Alumni, after which many from the School attended the reception in the Arena for the delegates attending the Centennial Celebration and the dedication of the Carillon at the Soldiers' Memorial Tower. In the early part of the evening there was the ceremony of the Ritual of the Calling of the Engineer, and at 10 o'clock a large and enthusiastic smoker in the Hall at the rear of Convocation Hall.

Friday noon a large number of class luncheons, all of which were well attended, and in the evening the School Dinner Dance at the King Edward was a brilliant affair. Many School men were also to be found at the Centenary Ball in Hart House.

Saturday morning the Annual Meeting of the Engineering Alumni was held in the Mining Building. At noon the bronze portrait bust of the late Dean John Galbraith was unveiled; a buffet luncheon was served, and for some time afterwards the Alumni wandered about the old buildings.

At 2 o'clock a record crowd attended the Rugby game between McGill and Toronto. We were sorry to lose, but it was a pretty game to watch.

Saturday night the undergraduate body invaded Casa Loma in numbers when the Dinner Dance proved to be a very brilliant function. At the same time the Alumni held the biggest and best dinner in its history at the King Edward Hotel.

The Sunday service at the Arena was one long to be remembered, with Canon Cody and President Falconer officiating, supported by the Mendelssohn Choir and the T.T.C. band.

The success of the past fifty years is a challenge to the graduates of the years to come, to an equal or better service to their fellow men, and the writer expects a progress even greater than has been, will be your reward. In the trying days of the Great War it was written of a School graduate, "And he kept the road open."

Permanent Executive

Gentlemen:

"Our four years' sojourn at the Little Red School House is drawing to a close. We cannot leave without some feeling of regret, some retrospective glance at the days passed by."

In such manner have all such well-wishy-washy wishes commenced, and therefore, not to be outdone by our mere predecessors, we are keeping up the old practice.

The cold, dreary world, and all that sort of thing will soon confront us. Not, of course that it matters at all to the world. We have an idea that the world isn't going to stand and confront us with drawn sword, and an evil leer, or with open arms and a virginal smile. We have a suspicion that a rapidly revolving door or a hell of a fast express train is a better metaphor for the good old world, and that the faster we jump and insinuate or insert ourselves, the hotter we will be.

It has been said that we have left our mark on the University. We agree with that idea. If several Intercollegiate captains, various cups and shields which are told about elsewhere, our very interesting social activities, (interesting to others as well as to ourselves,) are of any account, we could have done worse. As an aside, we might mention that certain academic honors have been won by some of our members. So perhaps we haven't failed in the purpose for which we were supposed to take these courses.

We have to remember some other things also. We must remember that we haven't just hung around this joint for the last four or five or so years just to leave it cold. We have made certain connections and so forth, and we ought to keep at least some of them going. Of course that is why you have elected us, just to keep things moving. But for god's sake remember that without the year's support the year cannot be kept together, and for your own sakes keep in touch with us. If you do that, we'll do the rest, and you can lay to that!

Here are our names, and our addresses are also here. We are on deck, and waiting for you. We are just anxious to have piles and piles of data all the time from now on.

President:
D. C. CARLISLE,
1 Schofield Ave., Toronto.

Secretary-Treasurer:
STUART BOLTON,
Oriole Road, Toronto.

Permanent Executive

W. R. DUNCAN

A. B. HUNT

G. F. TRIMBLE

W. M. CAMPBELL

K. K. FARAH

A. E. S. BOLTON
Sec.-Treas.

ENGINEERING SOCIETY STORE

Engineering Society Elections

This year School politics were handled in an entirely different manner than ever before. With the coming of a revision of the constitution of the Society also came a revision of the elections act. This year it was decided that owing to the calibre of former nomination meetings, it would be best to do away with this meeting and find a new method of holding the nominations. Thus it was arranged to open nominations on Monday and have each nomination carefully written on a form provided for the purpose and given to the Secretary of the Society. They were then pasted on a large chart in the Hall which kept all members informed of their progress. Nominations closed Tuesday afternoon with little or no excitement during the two days. This, however, was due to the fact that nominees were not allowed by the By-laws of the Society to proceed with their campaign until later.

At 4.30 Wednesday afternoon, C22 once again opened its doors to the traditional meeting. Yet, this time it was not to be the nomination meeting at which all members formerly gathered to do justice to the society by nominating men for the various offices of the Society and at the same time have as much hilarity as possible. No, it was a quiet sort of an affair. Few seat arms flew for they had been taken off beforehand. The candidates for the various offices were assembled in the front row. One by one they were called to the floor and introduced by Bill Duncan. According to the humor of the crowd were they greeted and heard. The meeting, however, lacked the old enthusiasm of the nomination meeting.

Enthusiasm ran high for the rest of the week. Every available conspicuous spot was used to post a sign of some description. Some even found their way into the drafting rooms. Cigarettes were scarce, yet there were the odd blotters circulating around. However, electioneering of this type was very limited.

Each year held its own meeting at which candidates for the Society as well as those for the year offices were given a chance to excel themselves. These developed into more or less of a story-telling competition which proved very entertaining. The meeting, most worthy of mention, was that of the Fourth year at which the nominees for the various offices of the permanent Executive orated. Those attending the meeting found it more than enjoyable, while many of the candidates found it embarrassing.

School, as was customary on election day, went to Hart House for luncheon. The members found their way to the Great Hall about 12.30 and soon all who were there assembled were aware of the fact that it was election day at School. After a hearty Hart House meal the men assembled in the East Common Room. There the usual methods of entertainment were employed. Many School songs were sung and stories told. Don. Beam did himself more than justice with a couple of his recitations and "Maggie" assisted nobly. Into this assemblage strolled the odd curious spectator who immediately found himself in difficulties. After shouting the Toike Oike and being jeered at and humiliated by School men who know how, he was given the rush à la porte.

After the entertainment the men left in a body for School. The usual rush on University College was made. However, the members of that institution, recalling previous years, had cautiously bolted all the doors. Thus this attack proved futile. The men proceeded across the Front Campus when a cry of "Poor School" rang out from the library. As one, they all turned and charged the library. Upon arrival the bold men who had uttered those words had retreated inside and the door was well guarded by "Scotty." There was not much of an argument here so the men proceeded to School.

Voting took place between the hours of 1.30 and 4.0 o'clock. It was carried out on all three floors of the School Building. The major part was done early and permitted the men to attend the various theatres. The Gayety, as on such occasions, was crowded, the men more or less doing as they pleased and even assisting the actresses in many cases.

Night found the members assembled in the Second year Drafting Room to receive the results and also partake of whatever sport might be available. Results were flashed on the walls for the benefit of those desiring them. Hiram Berry provided leadership for the noted group of songsters and rendered a solo whenever the noise abated. The usual keg of cider, biscuits, sandwiches and apples appeared. About 10 o'clock the noise died down and all dispersed more than satisfied that it had been a most successful election.

N. D. Adams.

Election Results

President .... R. B. Rochester
First Vice-President .... G. M. Gray
Second Vice-President .... G. H. McVean
Secretary .... J. R. White
Treasurer .... N. D. Adams

ATHLETIC ASSOCIATION

President .... J. M. Goss
Vice-President .... P. A. Ballachey
Secretary-Treasurer .... J. E. R. Wood (Accl.)

CLUB CHAIRMEN

Civil Club .... J. T. Anderson
M. & M. Club .... J. C. Annesley
M. & E. Club .... W. A. Rooke (Accl.)
Architectural Club .... J. H. A. Collins
Chemical Club .... W. D. Irwin (Accl.)
Chairman Debating Club .... D. G. W. McRea

STUDENTS' CHRISTIAN ASSOCIATION

President .... C. C. Parker

PERMANENT EXECUTIVE

President .... D. C. Carlisle
Vice-Presidents .... H. K. Farah
W. M. Campbell
A. B. Hunt
G. F. Trimble
W. A. Duncan
Secretary-Treasurer .... A. E. S. Bolton

FOURTH YEAR 2T9

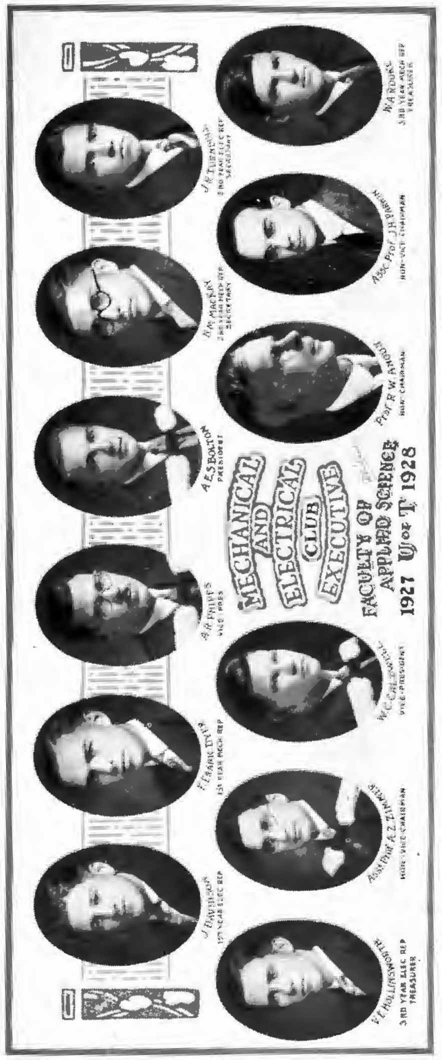
President .... J. D. Wright
Vice-President .... G. Rochereau de la Sablière
Secretary-Treasurer .... G. R. Lord
Athletic Rep. .... M. B. Furber (Accl.)

THIRD YEAR 3T0

President .... R. M. Ferguson
Vice-President .... E. K. Beam
Secretary-Treasurer .... H. L. Watts (Accl.)

SECOND YEAR 3T1

President .... D. H. Traynor
Vice-President .... A. E. Tyson
Secretary .... B. B. Puddy
Treasurer .... F. F. Dyer
Athletic Rep. .... W. C. Newman



The Mechanical and Electrical Club

The end of the session for 1927-28 is at hand, bringing to a close another round of trips, lectures, meetings and exams. Soon we will all be leaving the "Little Red School House", some only for a few months, when they will return and back Al. Rooke and his club for another year: for the rest of us, however, it means leaving our best four years behind, splitting up and looking, with the "Old School Spirit" and our trusty slip sticks, for new worlds to conquer.

The traditional fourth year trip to the Falls and Queenston departed from its usual form in that the gentlemen, and others, travelled by T.T.C. coach instead of by boat. The Queenston plant was reached about 11 o'clock, and after powdering their noses everyone descended to see what made the little Kilowatts run around and to get a sample if possible. Some seemed to be star gazing, but it is whispered that they belonged to the "Firefly Option". Dinner time found us at the Refectory with large appetites which were duly looked after. The Chippewa Intake as explained by Professor Angus and Johnny Fox proved of general interest. Howsomever, the treat was still waiting. When we arrived at the Niagara Power Company's plant across the bridge we were met by a genial chap with red hair, who, along with his brethren, began to let the hot air run wild. After a short stay in the States for eats, the coaches, filled in more ways than one, following a short stay for the Illumination, wended their way home amid songs and snores.

In December the Bell Telephone Company provided material for a very interesting open meeting held in room C-22. Mr. Macauley, the Chief Engineer of the Bell, introduced by Professor Rosebrugh, gave a short talk and then showed moving pictures which depicted the many difficulties and complications encountered in local and long distance telephone work.

On December 17th, an open meeting was held at U.T.S., where all and sundry tripped the light fantastic from eight to twelve with a short lay-off at ten for eats and repairs. This function was very successful, and I think it might well be adopted as an annual affair.

The last big trip of the year was held in January when about a hundred Schoolmen set sail from Hart House at 7.15 in T.T.C. coaches for Buffalo. The trip was unmarred except for the close Harmony of our lusty singers and a slight accident near Bridgeburg, where the other car came off second best, as always happens where Schoolmen are concerned. The Buffalo Chamber of Commerce furnished the eats and then the Lacawana Steel, Buffalo G.E. and the Pierce Arrow Works were visited, also a select few inspected the Curtis Aeroplane Works. The evening was spent in various pursuits, shows, dances and *cherchez la femme,* in which a few were so successful that they nearly got left.

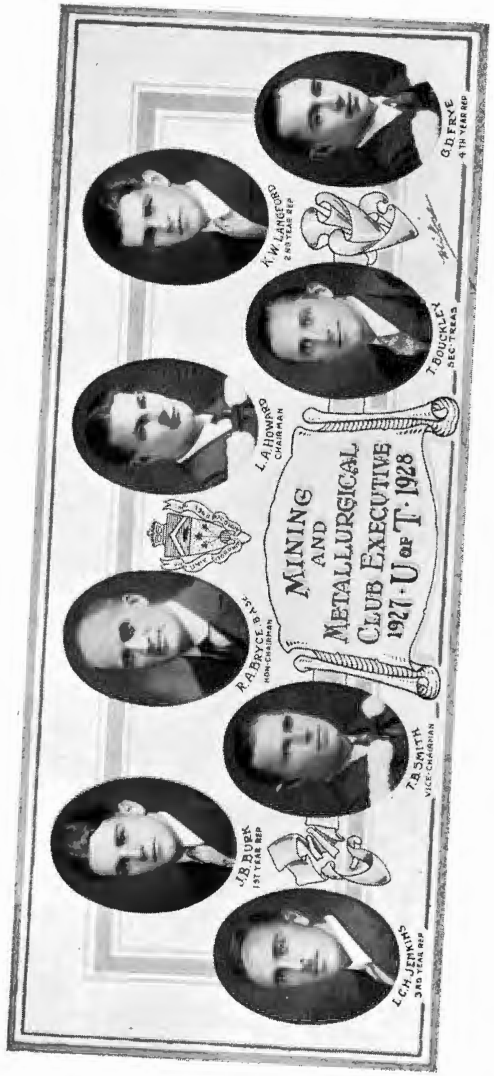
The new policy of the Club, that of having separate meetings and trips for the two sections Mechanical and Electrical, which would be of particular interest and use to them, was a decided success. The meetings were held at Hart House from 6 to 8, where papers, which were very fully discussed by those present, were delivered by members of the Section after a short sing-song and smoker. The trips of the Electrical Section, took in the Hillcrest Yards of the T.T.C. and the Adelaide Exchange, while the Mechanical Section inspected some plants in Dundas and Oshawa and also the Goodyear Tire and Rubber Company's Plant on the highway.

In closing I would like to thank the Staff and Members for their hearty support of this year's Executive and to solicit the same co-operation for next year's Executive which will be ably led by Al. Rooke.

STUART BOLTON, *Chairman.*

FOURTH YEAR MECHANICALS—1928

Holden, Lazier, Campbell, Smith, Mr. Saunders, Dill, Mr. Delaplante, Westervelt, Calnan, Caldwell.
Rowland, Loscombe, King, Professors Allcut, Parkin and Angus, Mr. Harlow, Klein, Brown.
Seated—Battye, Carlisle, Farah, Blasdale, Sheldon, Shenstone.
Insert—Scarth.



The Mining and Metallurgical Club

Let us mark off 1928 in red. The only thing we are sorry for is that we did not ask Mr. Bob Bryce to be our Honorary President a lot sooner than we did.

After the old custom, the first Club meeting in October was devoted to a welcome for the Freshmen and the more serious business of electing officers. As the membership of the Club has increased exceedingly in the last few years, it was deemed advisable this year to elect an official representative from each year to be either a Metallurgist or a Miner, and an assistant representative from the other department. It was an experiment well worth trying, and the executive deserve a lot of praise for the co-operation they have shown.

At the first formal meeting, the Club had the pleasure and good fortune to listen to Mr. J. C. Ruse describing a few of the points of interest of the Standard Stock Exchange. Mr. Bryce also gave an informal talk on the subject of Mining. Mr. Bryce later addressed the Club at an informal meeting held in Hart House, and the discussion that took place after dinner was found both valuable and interesting by all present.

At a meeting held in the Five Sisters Tea Room during the second term, Mr. Sidney Norman of Stobie, Forlong & Co., gave the Club an impression of Canadian Mining as seen in a different light by a Mining man who has spent part of his life in nearly every Mining district of the continent. He is an Englishman who has called the States his home but his optimism for Canadian Mining is unlimited.

One of the most valuable and amusing meetings of the year was that held in the Mining Building one afternoon at five o'clock, during the month of January. Mr. Jack Hammell gave an address which, not only kept his hearers in roars of laughter, but sent them away with a few points about Mining that they will always remember.

Mr. Balmer Neilly's address in February was one which showed a good deal of careful preparation, and in discussing Mining as a major aid to Canadian development, he touched on a subject which should be of great importance to every Mining engineer.

At a meeting held on Tuesday, February 14th in Hart House, Mr. Von Mawr, of the Consumer's Gas Co., gave a short talk on the subject of "Gas"—Natural, Artificial and Political—illustrated by slides that made it a most interesting lecture indeed.

It is impossible to say enough to express our appreciation and gratitude to Mr. Harry Kee for his address on March the 5th, on "Shaft Sinking at the McIntyre". It was originally planned as a one hour meeting Monday morning, but lectures were called off and lunch forgotten as Mr. Kee held his listeners for two and a half hours with a wonderful description of the science of engineering as applied in the sinking of the new No. 11 shaft at the McIntyre. We are extremely grateful to Mr. Kee for the time he spent and the information he gave us, and we look forward to a future address at the completion of his present job at the Frood.

The Club was also extremely fortunate in obtaining Mr. E. W. Todd's consent to deliver an address on Kirkland Lake. Mr. Todd is one of the Provincial Geolists, and his new report on the structures of this Camp is extremely interesting and valuable.

Socially, the Club can look back with pleasure to the afternoon when they were so kindly entertained by the Women of the Mining Institute, and we all hope that in some way we may show our appreciation for their interest in our Club.

If next year brings as large and enthusiastic a bunch of Freshmen as this year has, we will not only have an M. & M. Club to be proud of but we will play a still larger part in the activities of "School", and so to Jack Annesley goes the honour of giving some seventy or maybe eighty embryo Miners the opportunity of an education it is difficult to get elsewhere—the opportunity of learning from older men the tasks, the trials and the opportunities of a Mining or a Metallurgical profession.

LEWIS A. HOWARD, *Chairman.*

"We are Miners seeking riches . . . ."

The Industrial Chemical Club

Now the time has arrived to sum up the activities of the Chemical Club for 1927-28.

At the beginning of the fall term the Centenary Celebration held our attentions. The Chemical Club float helped to swell School's long display in the Centenary parade.

The first Smoker was held in Hart House in October, when the Club elections were held. Mr. C. F. Burk of 2T8 gave a very interesting and instructive address on "Water Filtration and Sterilization". The Fourth Year members of the Club enjoyed a trip to Longford in December. There they visited the Wood Distillation plant of the Standard Chemical Company and were royally entertained during their stay, by the staff of the Company.

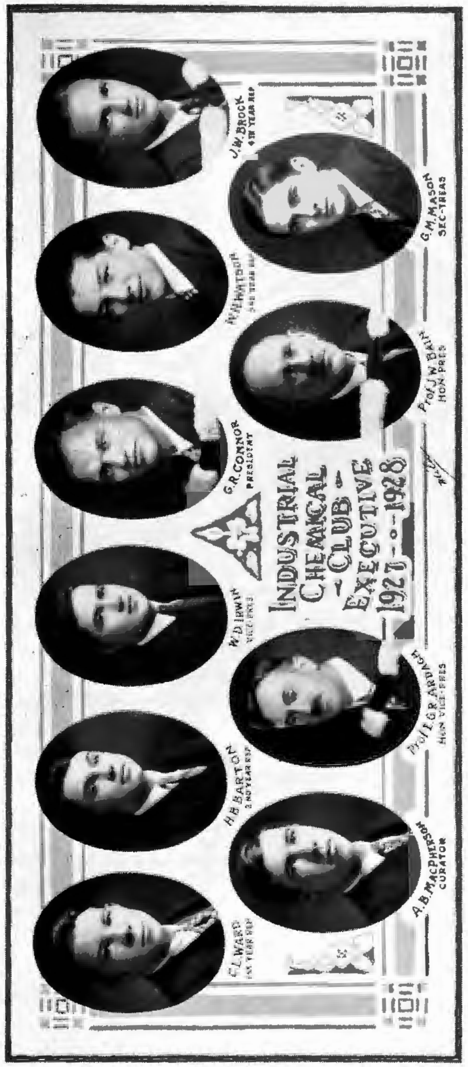
At the January meeting Mr. J. D. Hawken of the British American Oil Company, who was President of the Club in 1925-26, was the speaker. He gave us a summary of the methods of petroleum cracking employed by the Company in the Toronto plant and finished with an extensive talk on motor fuels. This speech was enjoyed by everyone present.

The Club as usual handed out the drinks at School Night. We hope everyone was satisfied, even though our supply ran short before 1 a.m. Mr. N. Helper of 3T0 was in charge of the booth and discharged his duties in a very capable manner.

Another trip was made in February. We left Toronto at 7.30 a.m. for Merritton, Ontario. The roads were very icy but we managed to arrive safely. At the Lincoln Mills we were met by some former members of the Club who showed us through the Sulphite Pulp and Lybster plants and explained the processes in use. From there we went to Niagara Falls, New York, where the Hooker Electrochemical Plant was inspected. This trip was a noteworthy one, in that Dean Mitchell accompanied us, as well as Professor Bain and Mr. E. A. Smith.

Mr. Ralph Kerr of 2T5, familiarly known as "Yukon Jake", addressed the Club at our next meeting. In his own inimitable manner he gave a most interesting and amusing account of his experiences since graduation, with, of course, a few pieces of poetry—for which he is famous—thrown in.

The Annual Dinner was held on March 15th, at the Five Sisters Tea Rooms. Mr. Mackenzie Williams of the A. E. Ames Company gave an address on the Financing of Chemical Organiza-

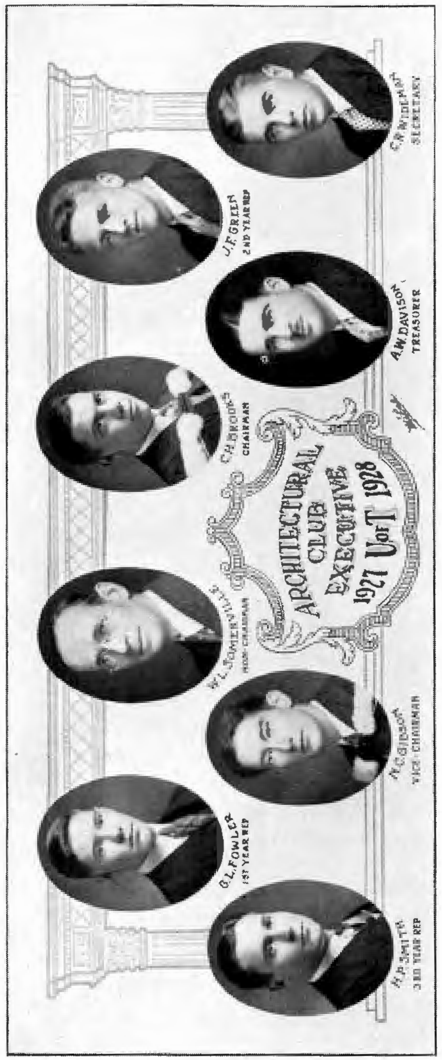


tions. During his undergraduate days, Mr. Williams helped to organize the Chemical Club and although not directly connected with the chemical industry at present, has never forgotten the "Little Red Schoolhouse", or the Department of Chemical Engineering. His experience in the financial world has been very extensive and his address was enjoyed by all present.

The successful candidate at the Annual Elections was Dean Irwin. Having been on the Executive for three years, holding the offices of Curator, Secretary Treasurer and Vice-President in turn, we have great hopes for the Club next year.

And now, may Fortune smile on the graduating members.

G. R. CONNOR, *Chairman*.



The Architectural Club

The fall sketching trips this year were a great success. The weather for the last few terms has been unfavorable, but this year the weatherman was kind, and there were some four or five trips unspoiled by rain. In spite of technique varying from throwing paint from a distance to applying it in small daubs, with the able tuition of Mr. Jeffries, a great deal of valuable work was done.

The first meeting of the year, which took the form of a dinner at the Grey Gables Tea Rooms, was well attended. After a good dinner our Honorary President, Mr. W. S. Somerville, regaled us with mock serious advice for those about to enter the profession. The club then adjourned to the drawing room where the freshmen amused us with speeches, music and skits.

At the next meeting held in the exhibition room, Mr. McGolpin of the National Fireproofing Company, gave us an interesting talk on hollow tile construction. Discussion of the difficulties involved in this type of construction followed. Tea was then served by our co-eds with the assistance of Miss Laing.

After Christmas another meeting was held, where Mr. T. A. Reid of The Athletic Association, gave us a lecture on Early Toronto. Mr. Reid possesses what is perhaps the finest collection of slides illustrating this subject. A selection of these slides was shown. Tea was served afterwards in the exhibition room.

This year may be termed a success for another reason—The Ontario Association of Architects Scholarship has been renewed. A scholarship has been presented by the Toronto Brick Company to the third year, and one has been presented to the fourth year by the office of Darling and Pearson, Architects. These are perhaps the finest things that the Club has acquired for some time. Apart from the prizes given to the winning students, advantage is gained in competitive work of the members of the year working for a scholarship.

Instead of putting on a skit this year at School Night, the Architects undertook, together with the Civil Club, to amuse the people wandering about the halls. A large white horse with brown spots was seen nosing about. This horse was really Harry Smith and Art Davison. Mr. Smith, who negotiated the back end complained that he could not make his knees bend backwards for the occasion. Members of the first and second years, dressed as troubadours could be heard singing ribald songs.

We might tell of a play, written by Mr. Middleton, presented by some of the students at a dinner given by the Ontario Association of Architects, at the King Edward Hotel, when local talent excelled itself and the mysteries of grease paint were shown the students. There was also the trip to the brick works at Milton by members of the third and fourth year and it would take volumes to tell of tappings, and why orange coloured smocks are found hanging on telephone wires. This account of the Club's activities during the year is in no wise complete. There were some hectic evenings in the draughting room, and the day of election speeches, and other doings, but these may not be mentioned here.

The outgoing executive hand over the reins to Jack Collins and his confreres, and we wish them all success.

C. H. Brooks, *Chairman.*

The Debating Club

It is agreed that the ability to speak clearly, convincingly, adequately and yet not verbosely, is necessary in any profession, especially in the engineering profession if one aims to become something more than a slide rule pusher. The ability to think clearly while on one's feet and to express one's thoughts in suitable words, comes only with practice. It is by practice that man acquires self-control, self-confidence, freedom from nervousness and a knowledge of the psychology of audiences.

The purpose of the Debating Club is to provide all comers with this practice in public speaking, and to provide competitive ground for those of an argumentative trend of mind. The open meetings held by the Club in which each man present expresses his own views, provide, we believe, the best way to eliminate the awkward tongue.

The executive were extremely fortunate in having Prof. Greaves of Victoria College address the club at the opening meeting on the art of public speaking. Prof. Greaves' address proved extremely interesting and his fund of humor provided much enjoyment for his audience.

In Inter-College Debating, School was elected to debate with McMaster University. Messrs. D. G. W. McRae and J. W. Argo supported the resolution "Resolved that Modern Industry and Capitalism are tending toward a catastrophe for the Working Class." It proved somewhat too much for Schoolmen to support such a Socialistic idea, and the catastrophe of which School spoke rather befell their own heads.

The ability and interest displayed in the Inter-Year debates were particularly gratifying. In the first of these the 4th year met the 3rd year in an argument "Resolved that the automobile is tending to raise the standards of mentality and morality of the people." The 4th year endeavoured to prove that automobiles had no bad influence on their morals but were not sustained.

The old rivals, the freshmen and sophomores, met in the second verbal conflict on the subject "Resolved that two hours a week, now devoted to draughting or laboratory work would be more profitably spent by students of the first and second year if devoted to the study of English and Public speaking". The freshmen, however, proved by their intuitive ability that such was not needed in their case.

In the final debate the sophisticated third year, opposed by the first year, were unable to persuade the judges "that the publicity given to crime and scandal in the daily press is justifiable." The first year will therefore have the custody of the Segsworth Shield for the ensuing year, on which will be inscribed the names of Dutton and Franklin. Those representing their respective years in this series in addition to the above were: C. F. Burke and H. M. Sheak for fourth year; L. C. H. Jenkins, A. W. Davidson, C. Parker and G. R. Lord for third year and A. L. Watson and V. M. Martinoff for second year.

The Oratorical Contest held at the close of the year's programme is a means of judging the degree of proficiency attained by rising orators. In the competition, J. W. Argo of 2T9 was awarded first place and the challenge trophy; C. F. Burke of 2T8 the second prize, while D. G. W. McRea of 2T9 ranked third.

We wish to thank Mr. Smith, Mr. MacLennan, Mr. D. D. Mossman, Prof. Zimmer and Prof. W. J. T. Wright, for the courtesy and support they have given the club.

Next year the work will be carried on under the able leadership of D. G. W. McRae and we trust that he will have excellent support.

WM. SHELDON, *Chairman.*

The Civil Club

Following tradition and as soon as the rush of Centenary activities and soph-frosh enterprise permitted, a trip to Welland was organized. Under the guidance of Prof. Treadgold and R. M. Downey, the entire canal system from Port Colbourne to Port Weller was inspected. The tremendous scale of the undertaking and engineering methods used were at once the objects of admiration and awe to the fifty odd Civils who made the trip. Lunch at Thorold and a bang up dinner at St. Catharines helped to round out a most enjoyable and profitable day. It is needless to add that the usual entertainments took place on the way home—as a matter of fact "unusual" would be more appropriate. Never were songs sung with such feeling and never have the natives of Grimsby seen such a sparkling and sprightly display of first-line stunts. In spite of the heavy rain, we had a good "house" there. The T.T.C. excelled itself in service and even the blasé Hamiltonians gave us a good hand.

Later in the fall, the fourth year members took part in an excursion to the new Ford Hotel, a steel frame structure with welded seniour trusses supporting concrete floors. Professors C. R. Young and W. J. Smither were in charge.

The first term was closed with the traditional smoker. Once more the Civils proved that science and art are sisters. First class vaudeville bills featured the evening, commencing with a theological burlesque "Bible Stories", staged by the 3rd year team and finishing with French-Canadian memories, by the one and only Don Beam. Everybody seemed to be happy and in return for the now famous two-bits admission, refreshments were served. Socially, the evening was a decided success.

There is one important event, in reviewing the year's activities, which cannot be overlooked—the inter-option hockey match. The old argument, which is the better option, Structural or Hydraulics, was decided this year and strange as it may seem, the criterion was hockey. The municipals, confident patrons, were neutral, providing substitutes, two to each team, with George Galimberti as referee. The pace set was hectic and it was only through the ice being soft that there were not more major injuries and near-fatal collisions. The battle staged by Al Flintoff and Tommy Granton would have delighted Lou Marsh himself. Doug. Laidlaw in goal for the losers saved his team times without number. The Structurals won handily 9-2. For the losers it must be said that they were trying hard.

In closing, the Civil Club wishes to extend thanks to:

Prof. Gillespie for his efforts in our behalf,

To Prof. C. R. Young for his courtesy and thoughtfulness for our advantage,

To Mr. Dunbar and Ralph Downie whose kind assistance and advice made the trip to Welland a great success,

To all Civil Club members for their support,

To Jasha Hvilivitsky and "Andy" Anderson for their good work. The latter is to be congratulated on his election to the chairmanship, and it is with a hope for real success that we pass over the reins to him.

MACDONALD SMITH, *Chairman.*

Being an Account of the Inter-option Battle waged by the Fourth Year Civils

Dissension has crept into the ranks of the fourth year Civils. The Structurals, secure in their drafting room, hurled taunts and curses toward the Mechanical building, the stronghold of the Hydraulic option. Boasts, challenges, and dirty looks were exchanged when these rival factions met on neutral ground. The Municipals, serenely industrious, wandered impartially between buildings, and just as impartially tapped any unwary member of either option that ventured into their midst.

Bridge at lunch-hour failed to establish any definite superiority. A pitched battle with T-beams and centrifugal pumps was discarded as being too effeminate, and finally hockey was decided on. The following conditions were imposed: game to be played during a lab. period; losers to entertain winners at Gaiety on Election Day (referee to pay for himself); Municipals to aid each team as decided by lot; individual responsibility for doctor's bills.

A day was decided on, ice secured, and a referee chosen. Finally, on the afternoon of the 1st of March there stepped upon the somewhat soft and crusty ice a gallant array of embryo C.E's; clad in motley colours, a grim look on each handsome face. Referee "Lou" Galimberti addressed a few chosen words to the teams, the goalies waddled to their respective nets,—a pause, the puck descended, and the epic struggle was on!

Not many minutes had passed ere "Yasha", receiving a beautiful pass from fifty feet behind him, drove the rubber past the watchful "Sunshine" for the opening tally. The Structurals, inspired by this brilliant play rained shots upon the Hydraulics' net. "Sunshine", like a veritable Vazini, got in the way of all but a couple, and the crisis passed. The battle raged up and down the ice. From a tangled knot of players the puck emerged, hotly pursued by Harry Smith, who, chasing it down the rink, guided it past the padded form of Don Beam, and into the hitherto virginal Structural twine.

The pace began to tell, strong men gasped and stumbled blindly to the sides; willing substitutes, eager for the fray, filled the gaps and fresh blood was spattered on the ice. For three full periods, Hydraulics and Structurals alike, skated, shot, broke sticks and heads, cursed, bumped, bodied and boarded, tripped and were tripped, in one grand fight for supremacy. Penalties were incurred by "Al" Flintoff, Flintoff, Tommy Granton, and A. F. Flintoff.

When the last gong sounded the Structurals were declared winners by approximately 6 to 2 (for exact score apply Bill Duncan). The score is not indicative of the play—no score could be. With the aftermath came reconciliation, and there is peace amongst the Fourth year Civils.

The following played brilliantly for their respective sides.

	STRUCTURALS	HYDRAULICS
Goal—	Don Beam	Doug. Laidlaw
Any place else—	Duncan, Magnon, Grant, Granton, Smith H. C., Moogk, Berry, MacDonald.	Flintoff, McGregor, Hall, Hvilivitzki, Grunsten, Sanderson, M. Smith

Referee— Galimberti

Timekeeper and Penalty Ditto—Robertson.

MACDONALD.

Gull Lake

Last summer brought together the smallest corps of Civils and Miners which has yet come to Survey Camp. By this I do not mean that the traditional spirit was lacking—far from it, in fact things were quite hot the first night they were together. The natives from near and far as well as visitors were summoned to a monstrous bonfire on the shore. Entertainment was provided, including spotlight dives from the high tower by Harold Nimmo and a faculty quartette—"In the evening by the moonlight".

During the day the boys were all out chopping down trees and fixing transits, or looking for places to put them. And of course they were always on time for grub; we had a real ancient mariner to wait on us. Poor old Cecil; he never seemed quite able to figure out what to do with the Missouri Sauce.

Of an evening, everyone to their various amusements—some paddled or walked four miles to theirs. We heard of a race up the river to a blonde amusement, and ever after Luke Emerson insisted on having the strongest paddle in camp—no reflection on Luke's prowess in a canoe. But he really preferred the big stone-scow for his nocturnal visits. Other items of which our fair Adonis is fond are Castor Oil, Gin Pills and Mud Turtles. (*Personal note*).

Camp developed not only engineers but some real hunters too,—every week end found someone tearing away on a canoe trip until duck-shooting became the popular sport. Apparently the difficulty was not to kill the duck but to tell what kind of a duck it had been. The Annual Regatta was scheduled for Labor Day but there were so many away over the holiday on these trips that it was officially postponed until next summer. The men went in all directions, some north to fish, others south to try and fish—Freddy Dunn went in search of a phantom wolf. (Freddy's interests were divided between Minden and tossing quoits.)

We must go no further without some mention of "Andy's old red whiskers". Andy was quite handsome for three or four weeks until the cook served up some soup. Now Cliff was not very fussy about "consommé au barbe" so he decided that the gauze was in the way, and off came the beard. It was whispered that the real reason was a square dance in the town hall. The camp flocked to the village for the occasion and kicked up such a row that the sheriff couldn't stand the pace.

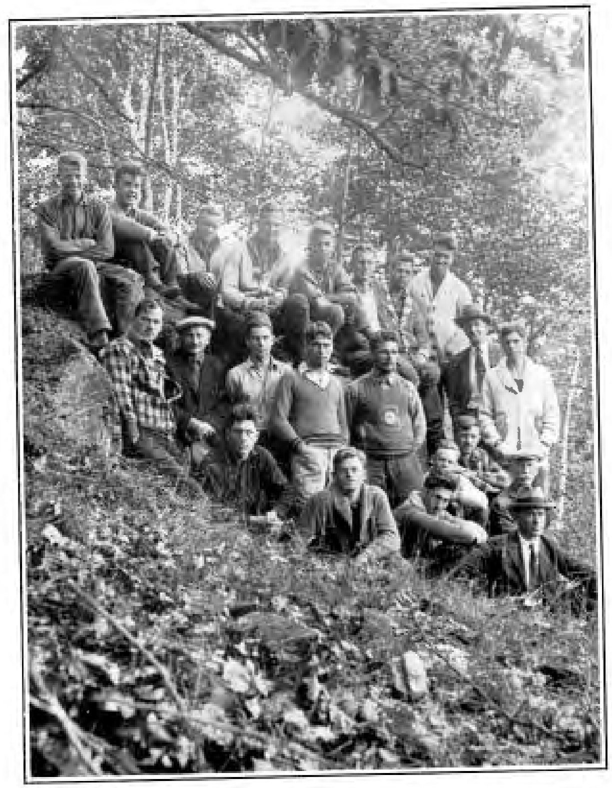
But speaking of dances—the bunk house looked really smart all bedecked with Autumn leaves and Evergreen. By no means the least part of the evening was the refreshment supplied by our patronesses. Things began to look very interesting when Gerry Gray and "Tommy the Lumberjack" almost came to blows. Doug MacCarthy didn't take actual part in the scrap but he sure did see red. Uncle Ernie very kindly offered the camp yacht to escort partners to the South end of the lake. The girls couldn't swim very well and whether Skipper Sutherland knew this or not when he stalled the boat about half way home has never been definitely ascertained.

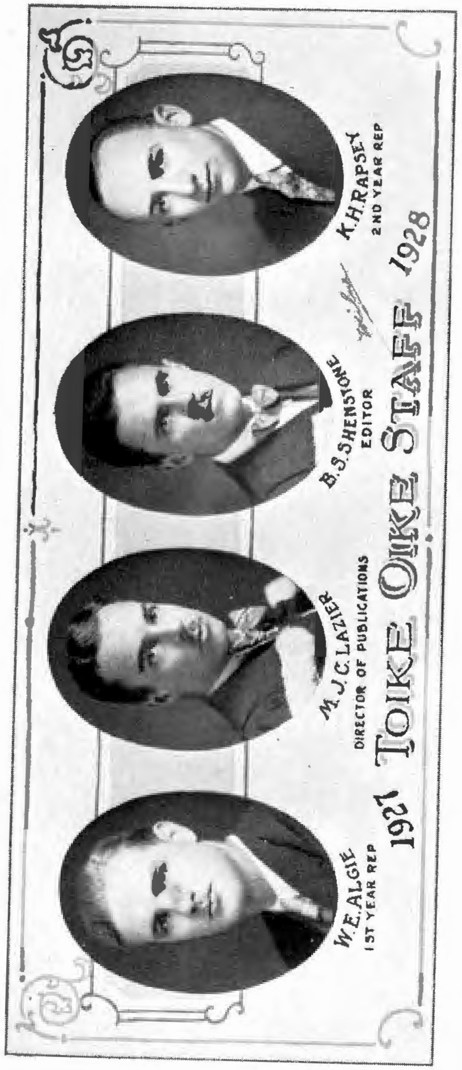
The last big event was the construction of a breakwater. Great credit is due Messrs. Argo, Parker and Co. for their diligent and untiring efforts in promoting this vast undertaking. There is no doubt that they had to cope with almost unsurmountable difficulties (such as preventing Hughie Ross from rolling boulders down the bank on top of the gang) in the erection of this ultra-modern feat of engineering.

Well, to make a short story long, all agreed that the "Little Red School House" should be moved to Gull Lake. Apparently the Faculty were of the same opinion because the pow-wow of Professors after the students broke camp is to be an annual affair.

In closing, my only advice to future Gullakemen is—get your initials on the wall of the bunk house early or there will be no more room.

Ogygites Canadensis.





School Night

Hart House was again the scene of much hilarity and merry making for the schoolman, past and present, on the night of Feb. 2nd, 1928, when our Annual Stunt Night was held.

That the function was a success we are sure, for had we not the evidence of 1500 happy and contented faces—on these, the committee and participants base their slim claim to immortality.

To one who visited the many stunts and shows it was very clear that the mind of the schoolman is a never ending fount of ingenuity. Among the shows that the midway devotee would have seen was first the "Radio skit", put on by our able brethren of the fourth year. High frequencies and "peep" shows held the West Common Room crowds breathless. Had one gone into the Reading Room, he would have been greeted by that Hoary Headed old ancestor of ours—Christopher Colombo and his crew of cut-throats, so ably depicted by the frequenters of that much maligned resort—Gull Lake. The East Common Room was the scene of jazzy melody and snappy repartee from the hands and tongues of the Miners and Metallurgists. They delighted the throngs, as only the M & M's can. The Music Room, scene of many an enjoyable afternoon recital, was ruled over by the second year men. Here were reproduced the favourite scenes from one of our local play houses. I do not need to mention the name but I'm sure many of us felt very much at home. Walking into the swimming tank, one found Johnny Joss and his Josslings sporting about in the briny, much to the amusement of the crowds that always pack the galleries of that popular place. For those who couldn't find their way into side shows the halls provided a never-ending source of laughter and curiosity. The fourth year Troubadours with their imported menagerie held sway here.

As is the custom, our frolic ended with dancing. Herb Smith, an old schoolman, providing excellent music for the devotees of the light fantastic.

The evening's enjoyment was considerably enhanced by the presence of Mrs. C. R. Young, Mrs. T. R. Loudon, and Mrs. J. H. Parkin, who graciously extended their patronage for the occasion. We were also glad to note that our Dean and many members of Faculty paid us a visit.

T. B. SMITH, *Chairman.*

The School At-Home

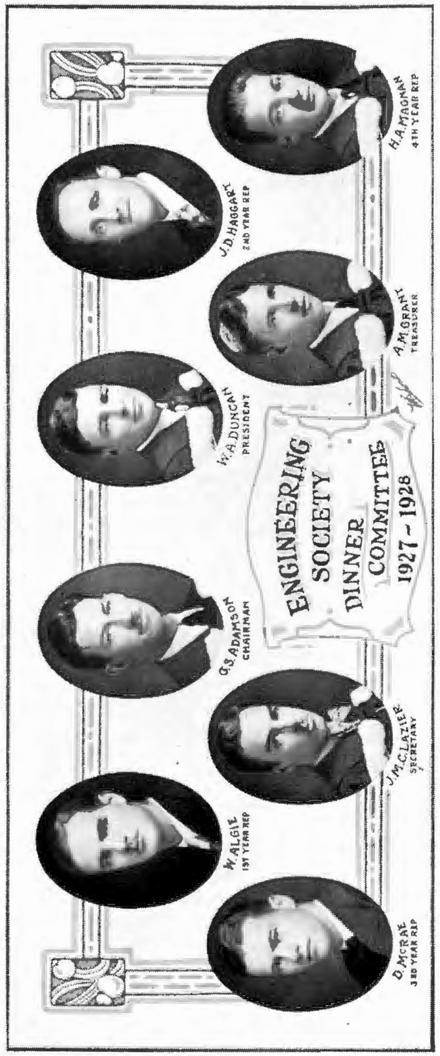
Music, laughter and the glamour of rainbow lights, laughing eyes and dancing feet, the Crystal Ball Room resounds to the strains of violins, and the sobbing of saxophones. A mad, glorious fantasy of swaying forms and shimmering lights. How far away are lectures now,—stuffy labs, drafting tables and books are forgotten, slide rules are discarded. The dance is on.

The next is a waltz, the lights are dimmed and a silver moon shines on the gay revellers. The novelty dance, streamers drifting, laughing couples dodging pith balls, and tripping over serpentine. Gay ladies put up diminutive parasols for it is raining confetti.

Then the nose-dive to the Victoria & Pickwick Rooms to supper. Clinking dishes and an army of waiters, favours for the ladies, and fruit cocktail for all. Cigarettes and chat, while the charming Ryan sisters provide delightful diversion.

Now back to the Ballroom. The lucky number dance made more interesting through the arrival of our Bohemian friends, with organ, monkey, dog, parrot, and whole menagerie, and an embarrassed Lochinvar and a blushing maid have to dance while spectators show their approval in showering them with balloons and streamers. Then the prize—"Oh, Gerry, how lovely—let's dance". And so on into the wee hours, till the orchestra will play no more. The long ride in the taxi. "Thanks so much—it was a wonderful party", and so it was.

But all is forgotten now. Long days of lectures, long nights of study, but the School man thinks as he puts out his light, after a grinding day of slide rule manipulation, "Oh well, it's not so bad, there will be another At-Home next year."



The School Dinner

A Head table across the dais of the Great Hall, with the dignitaries of the University, the State, and the Faculty making cheerful conventionalized black and white silhouettes against the arms on the wall, and all this in a light of becoming dimness, under that window, is a setting which would be difficult to duplicate anywhere on earth.

The School Dinner is always a satisfactory affair, but the one this year was exceptionally so, not only from the angle of the crass matter of eating, but from that of the more important matter of what was said. The toast to the University was proposed by the Rochester, hight Gummy, with a most engaging smoothness. Sir Robert replied, with great good nature, and told of the vicissitudes of eight o'clock lectures from the standpoint of the Faculty. He complained that the earnestness of the debate at the Council meeting had kept him awake.

The Faculty was proposed by T. B. Smith, and responded to by the Dean, while Douglas G. W. McRea gave the Profession. Professor Haultain responded for Mr. A. B. Cooper, the President of the Association of Professional Engineers. Harry T. Pritchard said nice things about the Sister Societies, and the representatives replied with happy thoughts about us, and pleasant stories.

The guest of the evening was The Honourable William Finlayson who gave a very interesting address on the work of the Department of Lands and Forests, especially with regard to re-forestation, how it is being carried out, to what extent, and the great importance of this work to the country. He pointed out that, heretofore, the practice had been to regard timber as an exhaustible resource, but that by propaganda and instruction by the forest rangers, helped by a few well conceived laws, the crop idea was becoming, fortunately, more prevalent. That is, that only mature timber is cut, and only as much as is desirable from the standpoint of good forest economics.

It was a dinner that was a success from start to the finish and one for which the Committee deserves a great deal of praise.

M. J. C. L.

The Graduating Year

Four years so swift in their flight, so far reaching in their purpose, have come and slipped away since the class of 2T8, in all the strength and vigor of buoyant youth, first entered the sacred precincts of S.P.S. Now, as we stand on the threshold of the Engineering Profession, we see ahead of us the seething whirl of business life. What it holds for us—we do not know, but we all carry into it the fond memories of four years of preparation.

All years were marked with many interests and outstanding achievements, but we feel that our final year was the crowning climax to them all. The successful part taken by our members in the celebration of the University Centenary and the Semi-Centennial of the School of Science predicted a win from the start. The designing and building of floats for the big parade, dances, dinners and all other forms of festivity gave opportunity of work for everyone and assistance was not lacking from any quarter. The General Centenary Committee of the University found no small portion of its executive ability and willing workers in the ranks of 2T8 School.

With this great week of festivity over we found ourselves approaching the customary Senior School Dance. Much controversy followed as to the advisability of another large function so close in the wake of the Centenary. The Engineering Society Executive advised its discontinuance for this year, but the senior years themselves finally decided the question in a formal vote where every member exercised his franchise. The day set for the big event came and passed, unhonoured and unsung, thus the will of the majority.

The Graduation Dance on February 9th, at Casa Loma, was as would be expected, the unrivalled criterion of our social activities. An exceptionally good attendance made the party a very jolly one and it will long be remembered as the last and best.

Election week was even bigger and better than ever. Thursday night before elections we were the guests of the Engineering Alumni Association at a Dinner and Smoker held at Hart House. This started off the election spirit in true style. A complete program was arranged for Friday and it was carried out with a great deal of interest. The high spots were election speeches, lunch, voting, the usual high class show and finally a wind-up-dinner at Hart House, before joining the rest of School at the big frolic in our second year drafting room.

On Monday, March 19th, the Engineering Profession took on a new guise to us all. "The Kipling Ritual of the Calling of an Engineer", so beautiful in its wording, so descriptive and inspiring in its thought, could not help but fill us with a new understanding of the profession. The scene in the Senate Chamber of Simcoe Hall is unforgettable—but enough—the iron ring tells its story and our life career will show its meaning.

Four intercollegiate captains is quite sufficient for us to say we have more than held our own in athletics. "Fran" Trimble, as rugby captain, well deserved the honour and confidence entrusted to him. The year showed their appreciation by electing him the most prominent man in athletics, and thus he received the athletic shield. Jim McKenzie lead the track team to a victorious intercollegiate title and his part taken in the interfaculty meet can hardly go unmentioned—he obtained more points himself than any single faculty. "Herb" Kirkpatrick was claimed by many sports but as captain of the "puck-chasers" he showed that he made no mistake in his major one. Bob Battye has always been on deck with his "jolly old ruggah", but this year as the "chief pusher" he has shown his outstanding worth and ability.

We have not only produced captains, but in all forms of sport, intercollegiate and interfaculty, we have men of prominence. However, realizing the impossibility of enumerating all of these men, we must refer to our list of T holders for a few of the outstanding intercollegiate men.

We must also include in this short history a few of those most prominent in the executive affairs of the Engineering Society, the nucleus of all our undergraduate activities. Bill Duncan, as president has brought in many improvements and we feel that the increased attendance and interest in the bi-weekly meetings of the Society, the outstanding financial success of the year and many other noteworthy things are due to his untiring interest and capable direction of the Society's affairs. Gord. Adamson, as vice-president, deserves great credit for the most successful dinner in years and the dance also has set a mark to be rivalled. The Athletic Society, under the direction of Harley Russell, himself an athlete of no small reputation, has made outstanding progress in the development of School Athletics. The Club Chairmen have kept their clubs active and full of interest. In fact, everything has gone ahead, there is not a dull organization to be found anywhere.

Thus our last year so full of activities and achievements has so quickly slipped by. It seems like yesterday that we registered, to-morrow we will be dispersed to the four corners of the earth, but always bound together by the undefinable "Spirit of School", which has made friends and acquaintances that will never be forgotten.

A. B. Hunt,
President.

The Graduation Dance

Casa Loma, in all its grandeur, has been the setting of many a festive evening; oft has the sound of music rung through its spacious halls and corridors, calling the young loves and old loves, the courting and frivolous wanderers to dance and be merry. On February 9th, the Graduation Dance of 2T8 passed into history ranking with the greatest of the great. The orchestra under the direction of Mr. Jardine, inspired by the atmosphere of such a castle sent the music, as of old, drifting and wandering through rooms and corridors, then back again content to stay with the more jolly crowd of Schoolmen in the State Ball Room from whence it originated.

What setting could be more appropriate for the Grad Dance? Added to all of this was the radiant and charming beauty of the fair maidens present, such as would be expected at any School party where Schoolmen are noted for their supreme judgment in the use of fillets, moments of inertia, odd harmonics, hyperbolics and all forms of curves which go to make up the "structural shape" that is so pleasing and intriguing to the eyes of the Engineer.

Supper which was served in the room across the hall, added in no small way to the general air of satisfaction which pervaded the function throughout. The supper tables were spread with all forms of delicacies and coloured novelties and favors of every description. Digestion was aided and abetted by Goldkette's inimitable trio. Many encores were called for and were so freely given that one would almost think that we could have exhausted their supply of new and novel ones—but not so. Their famous number the "Mississippi Mud" and a decidedly novel rendition of "The Old Mill Stream" were the high lights of a well balanced singing act.

Great interest was aroused by the lucky number dance, and a touch of comedy was provided in the spectacle of "Chick" Brooks and "Charlie" Furber, the chosen lucky men, who in regular Southern style ably burlesqued an honest-to-goodness crap game, with the assistance of a pair of six inch dice. The winner of the game won for his fair partner the most acceptable prize of a large French Doll.

The committee in charge wish to extend their thanks to Mrs. Mitchell, Mrs. Young, Mrs. Bain and Mrs. Parkin, who so kindly acted as patronesses, and to all those others who turned out and contributed to the success of this, our last party.

2T9

One bright and sunny day during the latter part of September in the year of Our Lord 1927 great noises and much blue smoke were found to be retreating from the far famed and notorious Mining Building of the University of Toronto. Upon investigation it was discovered that once again there assembled within its walls hardy men of the North—known to the world as Miners; men with long hair and pale faces—commonly called Architects; men with stained hands—of chemical fame; men with greasy figures—who class themselves as Mechanicals; men with brown faces—termed as Civils; and men with singed eyebrows—regarded as Electricals. Nevertheless they were the sages of 2T9, once more united, relating the new stock of stories—the result of the summer's outing.

During one more year has the year 2T9 displayed her genius in the different campus activities. With Johnnie Goss playing fish, Jack Dyment sword-slashing, Jack Keith breaking oars, Jack Williamson displaying his elbow grease on the horizontal bars, Jack Davenport doing his "stuff" on the end of a bamboo pole, we feel we are justly able to strut around "School."

But athletics alone do not attract all our attention. With such great stars among us as Jack Annesley, Gummy Rochester, Jack Wright, and Ken. Grogan, who has already signified his request to meet Paula Pierce in an open beauty contest, it may be well understood why the ladies for miles around assemble in Hart House for School Night.

The executive of 2T9, after due consideration, decided to give "the ladies about town" a treat. As a result two parties were arranged, at each of which the men of the year would collectively be open to the public eye for one evening, the first one of these being at U.T.S. in November, the second at Mosher's in March. It was easily seen, judging from the crowd present, that 2T9 is very efficient in figures.

Then, too, we must add a word or two about the illustrious deeds of 2T9 'ers at that most picturesque spot on one corner of Gull Lake.

It was about the middle of August A.D. 1927 that three or four of our most worthy sages in surveying decided to gather a few wondering miners and civils under their wings for five or six weeks and entertain them à la transit, chain and pegmatite dyke. Also to give the Civils a little practice in star gazing and the Miners some experience on that poor beautiful, much disturbed pegmatite dyke of which I have already made mention. However, a more detailed and illustrated account of Gull Lake doings will be found on other pages of this journal.

As the year now draws to a close, we pass on the robes of office and the year's bank book to Jack Wright as President and G. Rochereau de la Sablière as his Vice, and Ross Lord as keeper of the "Kale"—we wish them the best of luck in the year's activities.

G. M. Gray,
President.

The Junior School Dance

January the nineteenth, nineteen hundred and twenty-eight. Perchance some may recall this date, whether with pleasure or no, we cannot say. We are sure, however, that those with any means of transportation, from a Kiddie Car to a Stutz Safety Pin, will remember it.

On this night all available means and modes of conveyances were utilized. Truth is indeed stranger than fiction, for even the salesman's highly trained imagination would stand awed at the tales of what was actually accomplished, not to mention what took place in regard to some of even the smallest of cars. The School man along with every other modern youth has developed the science of economizing space to the standard of an art. Hence by 9 o'clock or thereabouts, many a blushing prairie flower had been transported from its native soil to the Pompeian room in the King Edward Hotel. Here every man had the flower dearest to his heart and took exceeding great care that it was not crushed by any but himself. To be quite truthful and honest, the dance was a most enjoyable affair, despite the excellent music, the fine favours, or, to use the feminine term cute favours, and the intoxicating moonlight waltzes. Of course, not being a miracle, the dance finally came to an end and so the early hours of the morning found us disturbing the peaceful slumbers of the neighbours with what was left of our exuberant spirits. Forgetting all this however, and becoming serious again, we wish to express our hearty thanks to our most generous patronesses, Mrs. C. H. Mitchell, Mrs. T. R. Loudon, Mrs. W. J. T. Wright, Mrs. J. J. Spence and Mrs. J. H. Parkin and also the energetic but humble committee G. H. McVean, N. D. Adams, R. M. Ferguson, W. E. Carruthers, T. W. Wilson, R. C. Williamson, C. L. Ward, and W. R. C. Warren.

3TO

Like every other person, from President Falconer down to the kind old lady who does a little work around and in and about Convocation Hall, the men and the lone female of 3T0 took part in the great Centenary Celebration of the University of Toronto. When this event had drawn to a close and no longer demanded our attention, being good and faithful students, we returned to our every-day duties. Chief amongst these was the education of subjects known as "The Poor Frosh" in certain routine matters regarding hats, ties and above all the high respect due to their seniors, Sophs and Professors. Taking the words, "A little work, a little play makes Johnny a bright boy", as their motto, the tie-bobbing and tapping parties were held according to custom. All these were, however, brought to a climax in the good old English Rugger football match held in the lower corridor of the "Little Red School House", and the initiation of the Freshmen in the Second year drafting room, the latter of course, did not approach the fields which the imaginations of the first year men had been wandering in, since listening to interesting and blood curdling tales of the intellectual fourth year man.

The outstanding event was, naturally, the Soph-Frosh banquet, indulged in at the Carls-Rite Hotel. Here all trivialities were forgotten, the Frosh were treated as ordinary human beings, the Sophs as the same by the professors and vice versa. Here, "Tommy" Louden, if we may be permitted to use that familiar sobriquet, in an oration on the derivation of the letters S.P.S. let the humourous side of his nature have sway, which is, perhaps, one reason why we are so attentive in his lectures. Following this the Dean, in a poetical manner, compared the experiences of first year men entering school to the adventures of of a man in a new country. We, with the experience of but one year behind us hope that they retain as many of the instructive phrases as the amusing ones.

Despite our claim of being of the type known as the "Big Silent Men of the North" we were broadminded enough to realize that the masculine members of this generation cannot entirely neglect their opposites of the feminine sex. Hence, after due thought and consideration, it was decided that we should play the part of martyrs for one night and allow the fair damsels the privilege of our society. It would not be appropriate to bring back memories of this eventful occasion, the year party, without a few fatherly words of advice to (Smithy) Smith and his partner in crime Park MacKay. For affairs at which Tuxedos or dinner jackets should or should not be worn, we, with our part experience and daily perusals of such society leaders as "Vanity Fair," "Vogue" and "May Fair", refer them to these with the passing remark that, circumstances should be taken into consideration and a great deal of discretion used.

Having supped of the "Wine of Feminine Association", the year became intoxicated thereby and without any doubts whatsoever enjoyed the warmth and satisfying glow felt thereupon. Consequently, once more must I describe pictures of the gay gallants of the year tripping the light fantastic over the ballroom floor of the King Edward Hotel on the historic night of January the nineteenth. Ah! what sweet smiles, what soft, warm, rose-perfumed lips do we remember, or perchance some are still cursing the unfortunate day that they were inveigled to that place by such a wanton little maid and swearing never to be caught again, that is, until another attractive little wench shall meet their gaze and then it will be the old, old story all over again. But, alas, so has it been from the time of Adam and Eve.

And still one more event must we chronicle before sheathing our pen and closing our minds to such sweet memories. School Night. Those words which carry such a wealth of laughter and merriment with them. How we did appreciate Scot Ferguson's bonny skit entitled "The Good Old Scottish Spirit", played by his cast to perfection.

Boasting is an acquirement of which it is not right to be proud. Nevertheless, we would not have you deem us without men of renown in fields of sport and scholastics. So, we are simply stating the fact that we have them, their names and accomplishments we will not deign to mention for they are one and all exceedingly shy and unobtrusive lads, and to shout their deeds to the world at large would but bring blushes to their handsome faces and embarrassments beyond counting. To close our year of activities come those inspiring things known as exams, so let us away to work, the striving with problems and in the end, success.

GERRY MCVEAN, *President.*

3T1

On the 26th of September, one hundred and ninety Freshmen and two Freshettes enrolled as members of 3T1. Being an exceptionally big year it took some time to get properly organized and consequently it suffered severely at the fierce onslaughts of the Sophomores. As a stranger in a strange country gradually becomes acclimatized, so did the Freshmen become accustomed to their surroundings and in a surprisingly short time they learned that the only way to traverse this new country was in groups.

Since all rough stuff was eliminated from the initiation the freshmen were commanded to put on skits to amuse their betters, and the Architects aided the other departments with a little rural scene which lasted about fifteen minutes. The initiation over, the Frosh did more or less as they pleased and after several skirmishes in which the Frosh were by no means the losers, the Sophomores enlisted the services of the 3rd year men and at ten o'clock marched to the East Portal to stem the tide. It was a superhuman task! For every Frosh that went down, two more appeared and slowly but surely they were coming in that sacred door. At the foot of the stairs the combined forces broke and only the timely arrival of the University Police saved the dignity of a 3rd year man from the humiliation of the tap.

The Soph-Frosh Banquet, held on Wednesday, November 9th, at the Carls-Rite Hotel, brought out a vast multitude of the first two years and also many Seniors, amongst whom there was great rivalry for the honour of being the man who had crashed the most Soph-Frosh Banquets.

Professor T. R. Loudon was the speaker of the evening and his parody on David and Goliath, in which he classed all Schoolmen as the sons of David and the Medes (or Meds.) as the followers of Goliath, brought honour upon School and congratulations upon himself. Dean Mitchell's address was, as always, short and to the point and extremely interesting. Workie did his stuff at the Head Table with a new(?) bag of jokes and he was second only to the Joffre sisters who gave a very hot exhibition of the Blackbottom. Woodside presented to all Frosh who had been successful at the Track meet, a real genuine leather medal. Undoubtedly it was a good party and if the number of Souvenirs taken is any indication it is one that will be remembered a long time.

Another very successful function in which 3T1 had a hand was the Junior School Dance held in the Pompeian room of the King Edward Hotel on Thursday, January 19th.

A class party was held at Parkdale Canoe Club on December 19th, as a Christmas farewell, and it was such a success that another hop was staged for Wednesday, February 8th, which was even more successful than the first.

The year of 3T1 has also taken her share in Athletics and a lot of credit is due to such men as Don Traynor from Saskatchewan, who made the Intercollegiate rugby team during the fall, and played basketball during the winter term. Tyson has started a promising career in the ring, while Hick, Hutchison, Newman and White have been doing their bit in basketball and Algy has been puck chasing. On the Track, Ballachey and Thompson showed their heels to a large entry.

On the whole 3T1 has had a very successful year, and we hope it may do still more to help School maintain the position she has held for so many years.

T. W. WILSON, *Pres.*

Toike Oike

We have been a bit more prolific this year than ever before, that is, within our memory of four years. Upon the sudden realization last fall that the frosh were upon us once again, and hordes of 'em at that, the usual frantic Frosh Edition was conceived. It appeared just in time, giving the much needed primary instruction.

Then suddenly the Centennial and the Semi-Centennial were come, with all the School grads in the world down upon us. The Word came, and the Centennial Edition issued forth, at the usual period of a day and a half after conception. Give praise to the Cobanites at the press, for they have suffered untold agony, and sweated amazingly for our Toike. The Centennial edition was spread among the grads at the King Eddy and also at the rugby game.

As usual, the Christmas issue in green type, which for some reason is supposed to express a jolly feeling or something, at least the press seem to think so. This color almost spoiled the effect of the fourth year statistical cut, the statistical analysis being on a very important and secret matter fit for seniors. (Except a certain few.)

School Night edition came out as a combined folder, program, time-table and direction finder, with rather vivid, but not at all exaggerated accounts of possible mysteries of the Nite.

Election edition, and the usual mass of ads, showing a set-up man gone mad. Kind of thing he'd get fired for, but he knew we wanted blatant, flaring, horrifying conglomerations of lettering, and by Gawd, we sure got it. He must have felt like the engineer who built the Eiffel Tower, an erection to make any nice ordinary shearer of plates or puncher of rivet holes have a foul desire to do a certain thing to the said engineer, which cannot be mentioned here with decorum. O Frosh, if you wish to know what that thing is, just show that Toike Oike to a high-class art printer, and LISTEN.

B. S. SHENSTONE.

School Athletics, 1927-28

The School Athletic Association

It is with pride that we review the activities of School in interfaculty athletics. This has been one of the greatest years in School's athletic history even though we won fewer championships than have been won in former years. This year we were represented by strong teams in every branch of sport, with the exception of tennis, and we are justly proud of the showing they made.

At the time of writing we have two championships to our credit. Due to the stellar work of Jim McKenzie, we piled up enough points at the interfaculty track meet to bring the Langford Rowell Cup back to School. As a matter of tradition our Crew did their stuff and once again brought the Interfaculty Rowing Championship to School. As both Junior and Senior Indoor Baseball teams and the Junior Basketball team are still in the running there are prospects of adding to the championships already won.

The Junior School Rugby team went through their group without a defeat and it was only after a close and exciting game that Victoria, the ultimate champions, eliminated them in the play-off. The soccer, swimming, water polo, and boxing, wrestling and fencing teams also made excellent showings this year. The water polo team in particular was one of the outstanding teams of the year. Great credit is due the Soccer, Track and Boxing, Wrestling and Fencing Clubs for the manner in which they functioned. The Track Club conducted the Soph-Frosh track meet in an excellent manner and the B. W. & F. Club staged a very successful inter-year assault.

The part taken by School men in Intercollegiate Athletics is a great source of pride to us. The "T" holders in School are, in most cases, the most outstanding athletes in the University. This is evinced by the fact that six of the Intercollegiate captains are School men.

The success or failure of the early lectures is a matter of personal opinion, and, unfortunately, many hold that the experiment was a failure. However, the fact that the annual trouble over skipped labs was not in evidence this year and that members of the Junior School Rugby team and the Soccer team found it easier to attend practices show that the main purpose of the change in timetable was achieved.

Much credit is due to the managers of the various teams for the work they did for School this year. The executive wish to thank all those who have so willingly given their time in this capacity to make this a successful year for the Athletic Association.

Harley Russell, *President.*

FINANCIAL STATEMENT OF THE S.P.S. ATHLETIC ASSOCIATION

To date March 10/28.

Assets:			
Balance 1926-27	$ 136.43		
To "S"	1.50		
Fees	1,094.00		
	$1,231.93		
Expenditures:			
Rugby			$ 237.75
Soccer			78.35
Hockey			103.85
Basketball			69.10
Track			21.50
Swimming			39.00
Baseball			25.35
B. W. & F.			30.25
Rowing			20.00
Transactions and Torontonensis			50.00
Tennis			14.00
Sundries—			
Milne Studios		$ 26.00	
Auditing		5.00	
Dr. Hobbs		3.00	
Signs		3.00	
Hart House		5.00	
Robt. Gaby		6.00	
Stamps, etc.		3.15	
			51.15
			$ 740.30
Cash on Hand			491.63
			$1,231.93

G. F. Trimble

D. J. McKenzie

School in Intercollegiate Sport

Six of the Intercollegiate Captains are Schoolmen! In Rugby, Hockey, Track, Swimming, Rugger and Gym., Engineers have been chosen as leaders, and each one of them has shown that he deserves the honour bestowed on him.

France Trimble—As Captain of the 1927-28 Rugby team, he has proved himself a born Captain and a star half-back. This is France's last year, and both the University and School will miss him.

Herb. Kirkpatrick—The Intercollegiate Hockey team has had a good leader in Herb. this year, and as a defence player he has turned in some good hockey for this, his last year at the University.

Jim McKenzie—Captain of the Intercollegiate Track Team and a Champion hurdler and broad-jumper. Jim has always been prominent in Track athletics, but this year he has beaten even his past records.

Johnny Goss—Captain of the Swimming team for 1928. John is one of the best swimmers in Canada and this year he has led the swimming team to another Intercollegiate victory. He will have a hard time next year, beating his own records.

Bob Battye—As Captain of the Varsity Rugger team, Bob has proved his worth as a brilliant player of his native game, "for he is an Englishman."

J. A. Williamson—Only in his third year, but his excellent work has merited for him the Captaincy of the Intercollegiate Gym Squad.

In spite of the long afternoon labs and lots of work, Schoolmen have always played a prominent part in University Athletics and this year has been no exception to the rule. The following list of men on Intercollegiate teams shows just what has been done, and why School has been at the top as usual.

Intercollegiate Rugby

Trimble—Captain.

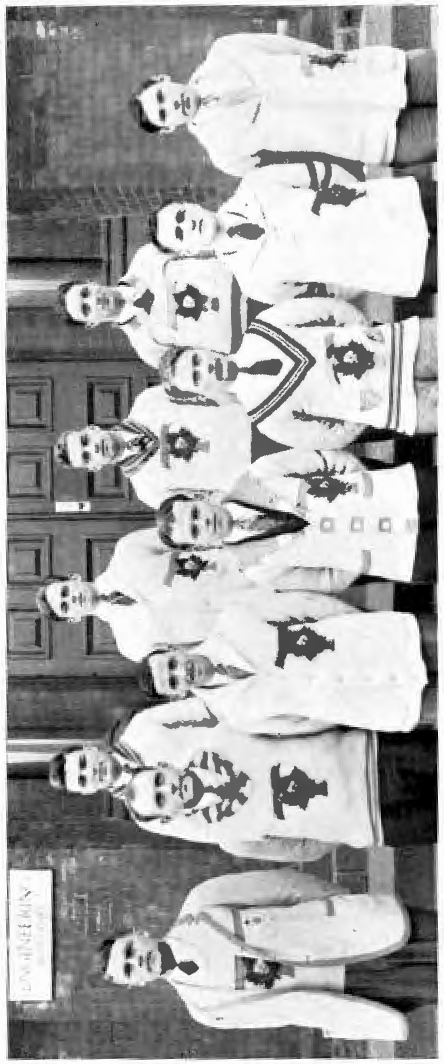
Kirkpatrick—a good outside wing who isn't afraid of anyone.

Traynor—first year, but has shown some wonderful ability already, and deserves a lot of praise.

Calnan—fourth year. An inside wing who could always be depended upon.

Hallam—second year. Some splendid work this year, with two more years to go!

School "T" Holders



Back Row: W. Duncan (*Rugby*), J. M. Goss (*Swimming*), G. F. Trimble (*Bugby, Capt., 1927*), G. Gray.
Front Row: R. B. Rochester (*Rowing*), E. Calnan (*Wrestling*), J. Davenport (*Track*), J. Williamson (*Gymnastics*), R. Battye (*English Rugger*), J. H. Russell (*Track*), H. . Nimmo (*Swimming*).

Senior O.R.F.U.

George Gray—Fourth year. One of the mainstays of the team for which he has merited a "T".

Swartman—Third year. Another of the old reliables.

Jerry Woods—Third year. It looks as if Jerry will duplicate his R.M.C. fame at Varsity.

Earl Davey—First year. Played a brilliant game on the half line. He has a position waiting for him on the Intercollegiate team next year.

Intercollegiate Track

D. J. McKenzie—Captain.

Jack Davenport—Canadian and Intercollegiate Pole Vault Champion.

Alex Grant—Finishing four years of successful endeavour on the track. He is a good middle distance man.

Swimming and Water Polo

Johnny Goss—Captain.

Intercollegiate Hockey

H. J. Kirkpatrick—Captain.

Boxing, Wrestling and Fencing

Vic Loscombe—Won the Intercollegiate 145 lb. title with a broken hand. This is Vic's last year.

Jerry Wood—2nd year. A light-heavyweight boxer who will do well next year.

Calnan—Intercollegiate Wrestling Champion, 174 lb. class.

Charlie Furber—4th year. 160 lb. wrestler.

Gymnastics

J. A. Williamson—Captain.

E. G. Heslop—2nd year. Showed some splendid form.

W. G. Heslop—2nd year. And he still has two years more.

Intercollegiate Basketball

C. W. Furber—4th year. A star forward.

C. W. Newman—4th year. Regular centre.

Senior School Rugby

Senior School had another lean year in rugby, losing three games and tieing another. It was not from lack of talent but rather lack of practice and the failure of the men to turn out for the games. The Centenary and Semi-Centennial celebrations also hindered because the first game was called almost as soon as School had really started.

School lost the first game to Sr. Meds, 8-1. This game was played with absolutely no practice and considering this the boys played well.

The next game was with Dents, and as School were still using the 'huddle' system they were again defeated.

Then the team got down to work, determined to win the remaining two games. Three of the regulars were unable to play Meds and the best School could do was to tie the score.

For the final game with Dents, twelve men turned out. They held Dents for the first half but conditions told in the second and Dents broke away for two touchdowns.

The following men played on the team:— Granton, Galimberti, T. L. MacDonald, D. F. MacDonald, McKinnon, Hall, Shields, Parkins, Hill, Nimmo, Kearns, McCarthy, Hopper, Hawtrey, Columbo, Shore, Smith.

H. C. Smith, *Manager.*

Senior School Hockey

Moving up a step or two from last year's standing, Senior School hockey team took second place in their group. The season for hockey was of the poorest, and exactly one month late in starting.

Without a practice "School" took on Dents for the first game and lost by several goals, but Meds were turned back twice, and Sr. U.C. once. The last tilt with U.C., however, was not played. The second game with Dents was not like the first, as "School" led for two periods but tired in the last stanza to lose by two goals.

Next year will bring better luck, and a better turn-out from third year will do more for "School". Only four men of the following are from 2T9:—

Flintoff, Gray, Mackinnon, Linke, Skelton, Allen, Jones, Granton, Sniffen, Swartman and Quinlan.

E. L. Sanderson,
Manager.

Junior School Rugby

Jr. School team were not quite so successful as last year, but it was a team that fought all the time, and School may justly be proud of them, for even if they did not win a championship they made a real bid for it.

In their group games they had little difficulty with Jr. Arts, but Jr. Meds gave same real opposition. Had it not been for the wonderful support given by the line, Hancock's kicking and Grosvenor's broken field running would have been of little avail.

After winning their group they got a bye and met Vic. in the semi-finals. In spite of the fact that they lost the game on a field which was six inches deep with muddy slime, they gave the champions the hardest game of the year.

Line-up,—

Algie, Campbell, Clark, Chalmers, Champagne, Davidson, Grosvenor, Hancock, Hardy, Langford, Little, McMordie, McVean, Smith, Watts, Wilson, White, Zieman, Scott, Duncan (Coach), Williamson (Manager).

Junior School Hockey

Despite the terrific handicap imposed on us by the mild weather, the Junior School Hockey team got away to a good start. Our group this year consisted of Jr. Meds, Sr. U.C., and Jr. S.P.S. The initial encounter with Junior Meds was a hotly contested battle from which we emerged with a 2-1 victory. People began to sit up and take notice; it is a long time since Junior School won its first game of the season.

With this game under their belts, the boys were rarin' to mix it with Junior U.C. Mild weather intervened, setting us back one week more, after having the whole schedule postponed two full weeks at first. When we met Arts we found them determined to win, but School could not see things in the same light. School got the first goal but U.C. rallied and poked one past Moeser. The battle see-sawed back and forth, neither team being able to score again. Thus our second game ended in a tie.

Junior Meds, prepared for revenge, met us the day after "School Night". The ice was sticky, the boys were still feeling the results of the festivities, and to crown it all, two of our best players, *viz.* "Bus" Hooper and "Norm" Smith, were absent through injuries. It was a "whale of a scrap". The score stood 1-1 with three minutes to go. Game as a fighting cock, School tore in on the Meds' citadel. Wham! The net sagged with the impact. School was ahead! Two minutes to go when the face-off occurred. Some choppy checking followed in School territory.

Meds bore in on us. Their right wing man shot from the blue line. The puck had no sooner struck Moeser's pads when the avenging stick of their centre man, who had been off side, swept it into the net. But Jack Sinclair, the referee, had failed to see the offside. It was a heart-breaking blow! Another game had ended in a tie, one which by all the laws of war should have gone to School.

A re-vamped U.C. team swept over us for a victory of 4-0 in our final game, played with the thermometer below zero. With Ross unable to play and Hooper still wobbly on his feet, the boys could not seem to hit their stride. If we had won the second game from Meds we would have had the group championship; as it was we lost by one point.

Karl Moeser in goal played a brilliant game and was most ably supported by Ross and Hooper on defence. Smith, Grosvenor, Haggart, Reid, Davidson, Higgins, Campbell, (Captain), and McDonald, composed the balance of the team, the first two deserving special mention for their fine work.

Since most of the team are first year men, much is expected of the 1928-29 Junior School Hockey team.

JOHN D. HAGGART, *Manager.*

Association Football

"A team feared by all!" Such applied to the School Soccer team of 1927-28, and will apply again to next year's team! And justly feared too, as our team was the strongest which has represented School for a number of years. Though we did not win our group, we make no apologies because the team that beat us went into the finals and, severely handicapped by injuries, and contrary to the "dope" of the critics, lost by a margin to Victoria.

This year School was grouped with Dents, Knox and U.C. All four games with Dents and U.C. we won with ease. We lost our first game to Knox by 2-1 and only their speed in clearing saved the day for them.

Our second game with Knox provided a choice morsel for the soccer fans and resulted in many near-cases of heart failure, for the Theologs' supporters. On at least six occasions, with only the Knox goalie to beat, that fickle Dame, Lady Luck, turned on us an eye of scorn. Knox won the game, 1-0, but only the "breaks" saved them from defeat and the necessity to replay us for the group championship. An Old Country footballer who had watched the game, remarked to us afterward, "You boys should have had that game by at least two goals."

The team this year was comprised of one fourth year man, nine second year men and three from first year. Harry Magnan, our stalwart half-back, has represented School on the soccer team for four years and has done his best to bring home the elusive silverware.

Though third year has contributed no players, 3T0 has more than filled the breach. Downing, an Intercollegiate man, McKay, Campbell, Haggart, Wyckoff and Helper, of second year, have all seen two years' service with the Blue and Gold. Further material was discovered this year in 3T0 in the persons of McDonald, Riddell and Bridge who proved themselves no mean exponents of the game.

From first year comes Hooper, Franklin and Ward who showed exceptional ability. We have no doubt but that there is plenty of fine material in this same class, judging by the first practice of the year, but most of the fellows failed to turn out, "Do your stuff, 3T1!"

Though Jim Downing is the only School man on the Intercollegiate Soccer team we should not be surprised to see Helper, McKay and Ward step up with him. Their playing throughout the year was consistent and of the highest order.

The change of Downing from outside left to centre marked an increase in the aggressiveness of the team. "Nate" Helper's work in goal was the greatest feature of the back division. Bus Hooper paired nicely with Harry Magnan and permitted Alex McKay to move up to centre half where his work, supplemented

School Track Team

Back Row: A. M. Grant (*Pres.*), P. Ballachey, C. W. Woodside, G. M. Mason.
Front Row: J. W. Emerson, J. L. Davenport, Prof. E. A. Allcut (*Hon. Pres.*), D. J. MacKenzie, J. H. P. Russell.

by the other two half-backs, created an outside defence second to none. Watch this young chap, Ward, recently from England! His work at outside right is a treat to watch.

The hearty co-operation and fine brand of sportsmanship displayed by the players; their willingness, sincerity and indefatigable efforts have knit the organization into a unit, upholding the high standards of School endeavours, and adding greatly to her prestige.

The best wishes of the team go with Harry Magnan and the graduating year. We can assure them that the School Soccer will continue to carry on the School Spirit of which they are so proud.

The personnel of the 1927-28 team is as follows:
Goal—Helper
Backs—Magnan, Hooper
Halves—Ridell, McKay, Captain Haggart
Forwards—Franklin, McDonald, Downing, Campbell, Ward, Wyckoff, Bridge.

JOHN D. HAGGART,
Manager.

Track

Another year has passed by and School has yet again added to her track laurels, by winning the Interfaculty Track Championship.

The interyear field-day was discontinued this year on account of difficulty in securing sufficient time allowance, influenced no doubt by the many holidays already given for the Centennial celebrations. To take its place, however, a soph-frosh meet was held. To "Woody" Woodside goes the credit for a successful day.

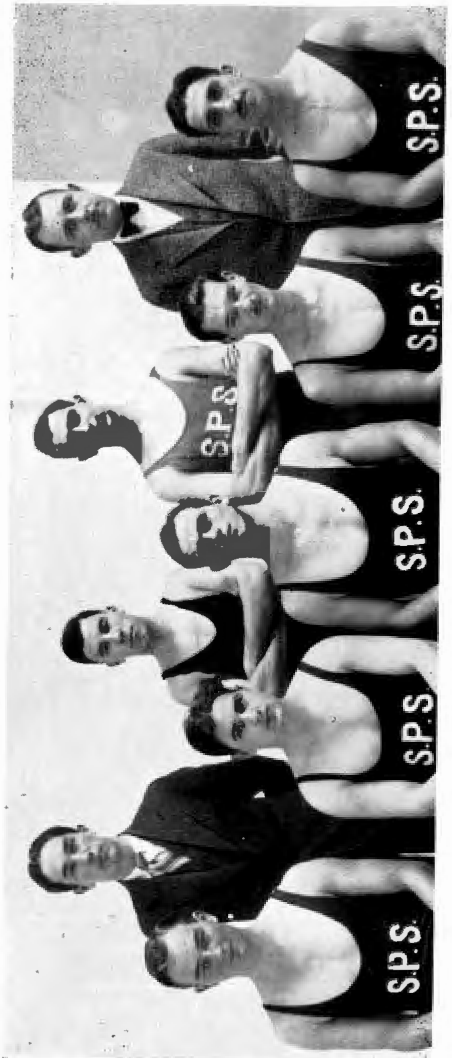
The interfaculty meet after two bad starts, got away on Friday, Oct. 14th. School won the meet with 39 points, followed by U.C. with 22. The outstanding feature of the day was the record breaking performance of D. J. MacKenzie who, alone, scored 23 points—enough to win the meet single-handed—certainly a great achievement!

Other members scoring points were—J. H. Russell, J. Davenport, C. F. Burke, G. Mason, J. Emerson, C. W. Woodside and P. Ballachey. Following the custom of past years, School track jerseys were presented to the new members on the team.

School was well represented on the championship Intercollegiate team. D. J. MacKenzie was elected captain, and Davenport and Russell were members.

In the Indoor Meet held weekly on the Hart House track, School ran into some real tough luck, losing out a number of times on close "time" decisions. U.C. won the meet with 49 points, followed by School with 35. The splendid jump made by

Senior School Water Polo Team



W. Enouy (*Coach*), H. Hermance, Jr., L. Bullen, H. Connery (*Mgr.*), D. McCarthy, D. Irwin, J. Goss (*Capt.*), L. Howard, H. Farah.

Jack Davenport in setting a new indoor pole vault record of 11 ft. 1¾ in. is well worthy of mention.

This year will see the last of a number of men who have helped uphold the supremacy of School in track. They are D. J. MacKenzie, J. H. Russell, G. B. Smith, C. F. Burke, and A. M. Grant. The places of these men must be filled by men from the lower years, and it is up to you to see that such is the case if School is to carry on with the measure of success that has marked her past performances.

A. McG. Grant.

B. W. & F. Club

This year the School B. W. & F. Club has certainly shown a lot of life, and proved that the "meek and peaceful" schoolmen have not forgotten the use of their hands.

The first activity of the club was the inter-year assault. This proved a complete success, uncovering some good material. All of the bouts were very interesting, and, although some of the combatants were inexperienced, they were all game, and showed that schoolmen are good sports.

This year the Athletic Association allowed more money to the club, so it was possible to give silver medals to the winners of the inter-year assault. This made it easier for the executive to raise the interest of the men, and much of the success was due to this.

The freshmen have shown much interest, and there are great hopes for them in future years. They lacked, however, the experience that third year has had with Meds., and so were beaten by them in the assault.

In the inter-faculty assaults School was well represented, and although she didn't win the senior, she came a close second. and if it hadn't been for a little hard luck, the silverware would have come to School after many years in Guelph, but "while there is life there is hope."

In the Varsity B. W. & F. team, School had as many if not more men than any other faculty. The men were as follows:

Boxing:

Vic. Loscombe.—Last year, through injuries, he was unable to represent the University, but this year, even though he had a broken hand, he came through with the intercollegiate title.

Jerry Woods.—A rugby player and a good athlete. He didn't have Vic's experience, but he is only in his second year, so before he gets through he'll certainly be dangerous.

Wrestling:

Ed. Calnan.—No small praise can be given to Ed. For the second time he won the intercollegiate title. He is also a rugby player and an oarsman. If he would train he would have a good chance for the Olympics.

Charlie Furber.—A clean and fast wrestler. In the intercollegiate he won from the McGill man, but although the Queen's man, who had just beaten the Canadian champ., beat him, he put up a game fight and sometimes he even seemed to have the advantage.

FENCING:

Jack Dyment.—This is Jack's second year in the team, and this time he won the title easily. We are sure he could cross swords with, or even teach the great swordsmen of Dumas' creation.

Many more men that have shown good promise could be named, but the list would be far too long.

M. B. FURBER, *Secretary.*

Rowing

School has again lived up to her fine record in Interfaculty Rowing, but not without strong opposition from the other faculties. During the week previous to Saturday, October 22nd, on which day the Regatta was held, the men turned out morning and night to get into as good shape as the short time would permit. The Interfaculty Regatta is primarily to encourage new men. So great was the enthusiasm that two crews had to be formed to represent School, and it was not until the day before the races that the crews were finally chosen. School's First Crew disposed of Arts and Meds in the first and third races while School's Second Crew won from Victoria in the second race and lost to Dents in the fourth race. The final race found School's First Crew and Dents on the line at the foot of Church Street. At the crack of the gun every man exerted his utmost but neither crew gained any advantage from the start. Dents managed to pull out a slight lead and then School extended themselves to even the crews again. The race developed into a see-saw affair and finally School managed to pull out the lead which gave them the race by about half a length. This was undoubtedly the best race the Interfaculty Regattas have seen. It was a great race to win and a hard one to lose but it can be said that the winner could not be declared until the finish line at the foot of John Street was crossed.

This year, the Olympic trials will take place, the winner of which is to represent Canada at the Olympic Games. School men have always been prominent in Varsity rowing and can be counted on to do their utmost to give Old Varsity the honour that was hers in the 1924 Olympics, when Varsity's Eight was second only to Yale.

School Crew

Back Row: I. K. Chalmers (*Cox*), D. G. W. McRae (3), R. E. Clark (2), H. E. Davison (*Bow*).
Front Row: W. M. Campbell (*Stroke*), G. G. Milne (7), E. G. Moogk (6), B. C. Blasdale (5), W. A. Watts (4).

Junior School Baseball

After an absence of several years, the Spalding Cup has once more returned to School. Although the group was rather easily won, Junior Dents supplying the only serious opposition, the semi-finals and finals supplied some real competition. After Senior Dents were disposed of by the odd game in three, O.A.C. came to town for the final sudden-death game. After eleven strenuous and very close innings, School emerged with a six to five win. This game was the closest of the season and the better team won.

The regular line-up consisted of Doug. Southam, pitcher; Irv. Chalmers, catcher; Jimmie Edmonds, 1st base; Bill Campbell, 2nd base; Rus. Armstrong, s.s.; Bill Edmonds, third base; Jerry McVean, Dave Reid and Roger Clute, outfielders. The good batting and fielding of this collection was the high light of all the games. Doug. Southam deserves special credit for his consistent pitching all year.

The spares consisted of Rolly Graham, Joe Higgins and Scott Ferguson, and they always fitted well into the championship machine.

J. W. S. Ferguson, *Manager.*

School in Swimming and Water Polo

With the exception of 2 or 3 men, the Junior Polo team was composed of novice players, who, although they did not make the championship series, showed promise of becoming just about the snappiest bit of clockwork that ever entered the Hart House Pool.

As regards the Seniors, they left the Eckhardt Trophy to U.C., but the Arts men were so scared in the last game that it is a wonder that they did win. However, next year, with organized, combined Junior-Senior practice periods, and good coaching, the Interfaculty Polo Cup will just naturally toddle down to the "Little Red School-house".

Swimming early found favour with the frosh and they deserve a great deal of credit for the splendid turn-out to the Annual Inter-faculty Meet last fall. The fact that School did not win is no indication of the merits of her supporters, and with a little more appreciative interest as with the Water Polo there may be a different story to tell in 1929.

Let's go, boys—bring the Aquatic honours back to where they belong—and why not?

J. M. Goss.

Junior School Basketball

Those who would read a tale of a long unbroken string of victories ending in a splendid last-minute rally to win the coveted trophy, may turn the page.

It was the same fine season and the same inglorious ending as last year. Again there was gathered together a splendid team of basketeers, a team that practised and hustled all season, yet could not "get together" at the final test. Practices were commenced in November, and some 32 frosh besides the remaining regulars from last year's squad turned out. By Christmas a squad of 10 men, containing many Varsity junior regulars, were rounded into fine form. After the new year the first two group games were taken handily and the top-notch teams of other groups defeated in exhibitions, all leading the team to be considered as favourites for the cup.

Then came the break. While pluckily playing though suffering from flu, the popular captain and pivot man of the team, Earl Davey, a star of intercollegiate calibre, went down with a bad heart and was out for the year. Although the game was lost to St. Mike's, a strong aggregation, the team came back to win the group play-off from them. At this stage the unfortunate incident of trimming the Forestry team badly in an exhibition game caused an attack of over-confidence which resulted a week later in their elimination by a meagre 6 points in a two-game series with this same team. The Foresters had the fight, and School were lacking their usual form. Their shots rimmed the basket, in fact did everything but go in, and that is the story. Basketball championships are not won on paper, and Junior School went the same way as the doughty Marlboro junior hockeyists in their ill-fated quest for Canadian honours. It is a new experience for mighty S.P.S. to bow to a faculty of some 50 men—but more power to Forestry; may they go through to the Sifton Cup.

C. W. Woodside, Mgr.

Senior School Basketball

Senior School's attempt at the Sifton Cup proved unsuccessful this year. Pre-season hopes ran high, but a winning team failed to materialize. We were grouped with Senior Vic., and Senior Dents, and own it no disgrace to have been beaten by teams of the calibre they fielded this year.

The team, strengthened by many of last year's Junior school aggregation, gave an excellent account of itself, and though credited with only one win, made our opponents extend themselves.

Let us all come back next fall with the resolution that the Sifton Cup will again take up its residence under a glass cover in the Little Red Schoolhouse where everyone may see it and say again, "Well done, School!" So often have our hopes and chances for the trophy rimmed the basket, hesitating in the balance whether to go in or to fall to the ground again, but next year we hope that Senior School will make every shot straight and clean for the basket—and the Sifton Cup!

The team consisted of:—Trimble (Capt.), Collins, Parkins, Swartman, Shiells, McKinney, Woodside, Emerson.

G. U. MacDonald (*Manager*)

English Rugby

English Rugby, better known as "Rugger", is still one of the few Intercollegiate sports which has no Interfaculty teams. Nevertheless, School men have always taken a very active part in this game and this year was no exception.

Varsity's five year hold has at last been broken by McGill who have won the title this year for the first time since Rugger was started. This was by no means due to the lowering of Varsity's standard, but on the contrary, Varsity this year played better Rugger than has ever before been seen on the campus. McGill's superiority this year was due chiefly to the advantage of having in Montreal five newly formed clubs with which they can compete and consequently gain by the experience. Next year we shall have two new clubs in Toronto with which we expect to play and benefit in the same way as McGill.

In the home and home series this year, McGill defeated us in the first game twenty to nil. This large score was caused probably by the fact that three of Varsity's regular players were laid up with injuries. The second game, played in Toronto, was much more even, in fact it was only in the last five minutes that McGill scored three points, thus winning the series twenty-three to nil.

Next year the captain is again in "School", which, by the way, has had the captain for the past five years.

"School" has always led the way in "Rugger"—and always will. How about it?

A. R. Battye
Captain—1927.

Senior School Baseball

Senior School experienced a really good year, and rightly so, for they boasted an excellent team. Unfortunately, Sr. Dents managed to score a few more runs than Sr. School in the final tilt, which was a play-off game for the series. School had the record of only having lost one game up until the final contest. This notable showing was due to the co-operation of the men.

George Smith pitched excellent ball all year, and Caldwell (W. C.) gave him all the support that could be expected of any catcher. Tommy Granton seemed to find it hard to let anything go by him, and when he did, "Maggy" Magnan nipped any opposition off second bag. The "Siamese Twins", Flintoff and Galimberti, played air-tight short and third, and when anything went over their heads, Mickie MacDonald, Syd. Jones or Bill Duncan made a hot scramble for the old pill. Mac Smith "done himself noble" with both his hitting and his fielding. All round, Sr. School couldn't have fielded a heavier hitting team, and it was just unfortunate that the last game didn't fall our way.

Here's hoping that next year may see a better team, if it is possible to have one, to represent Senior School.

Gordon A. Holden,
Manager.

Tennis

The usual Interfaculty Tennis Tournament was held last fall on the courts of the Toronto Tennis Club. This tournament decides the Intercollegiate Tennis Team, and in the latter rounds some excellent tennis was displayed.

The entry from School was not particularly large considering the size of our faculty, but those who did enter gave a fair account of themselves.

Arthur Boultbee progressed very well indeed till he encountered Donald Gunn in the third round. He was defeated after a hard three-set match and qualified for the challenge round. Donald Beath, who eventually made the team, eliminated Boultbee in the second round of this tournament. Harold Magnan was unable to get in any playing during the summer, being far in the wilds of the North, and did not consider it worth while entering.

A game of tennis is an asset very worth while, and is something that can be used all through life, few other games giving such opportunities for recreation and exercise for the professional man.

R. G. Robertson.

BALANCE SHEET OF THE ENGINEERING SOCIETY U. OF T.

February 29, 1928

Assets

Cash on hand	$ 191.56	
Cash in Bank—Current	1,020.07	
Cash in Bank—Savings	1,138.15	
		$2,349.78
Accounts Receivable	375.68	
Suspense—Returned Cheques	71.02	
Employment	60.00	
	506.70	
Less Reserve	126.12	
		380.58
Merchandise on Hand		3,458.79
Investments—Victory Bonds		1,500.00
Office Equipment	624.29	
Less Depreciation	350.00	
		274.29
Smoking Room Furniture	70.00	
Less Depreciation	60.00	
		10.00
		$7,973.44

Liabilities

Accounts Payable	$ 308.56
Civil Club—In Trust	15.27
Centenary Committee	24.02
Surplus Account	7,625.59
	$7,973.44

BALANCE SHEET OF THE ENGINEERING SOCIETY U. OF T.

Operating Account—Supply Department
Mar. 31/27 to Feb. 29/28.

Inventory—March 31/27	$2,500.00		Sales	$9,002.97
Mdse. Purchases	7,643.46			
	10,143.46			
Less Inventory, Feb. 29/28	3,458.79			
		$6,684.67		
Gross Profit to Gen. Operating Acc.		2,318.30		
		$9,002.97		$9,002.97

General Operating Account—Mar. 31/27 to Feb. 29/28.

Salaries	$ 530.00		By Gross Profit Supply Dept.	$2,318.30
Publications	255.71		By Fees	1,094.00
General Expense	528.80		By Interest and Discount	28.33
Dinner	25.84			
Grants to Clubs	35.00			
Donations	40.00			
School Night	4.11			
Printing and Stationery	80.00			
School "At Home"	203.17			
		$1,702.63		
Net Profit to Surplus Acc.		1,738.00		
		$3,440.63		$3,440.63

Summary of Surplus Account

To Balance Forward Feb. 29/28	$7,625.59	By Balance Mar. 31/27	$5,887.59
		By Net Profit—Operating Acc.	1,738.00
	$7,625.5		$7,625.59

February Sundry Expense Items

Entertainment, etc.	$50.38	
Expenses of Delegates	35.00	
Piano	17.00	
Sundry	14.20	
		$116.58