TRANSACTIONS and YEAR BOOK

of

The University of Toronto Engineering Society

April, 1927

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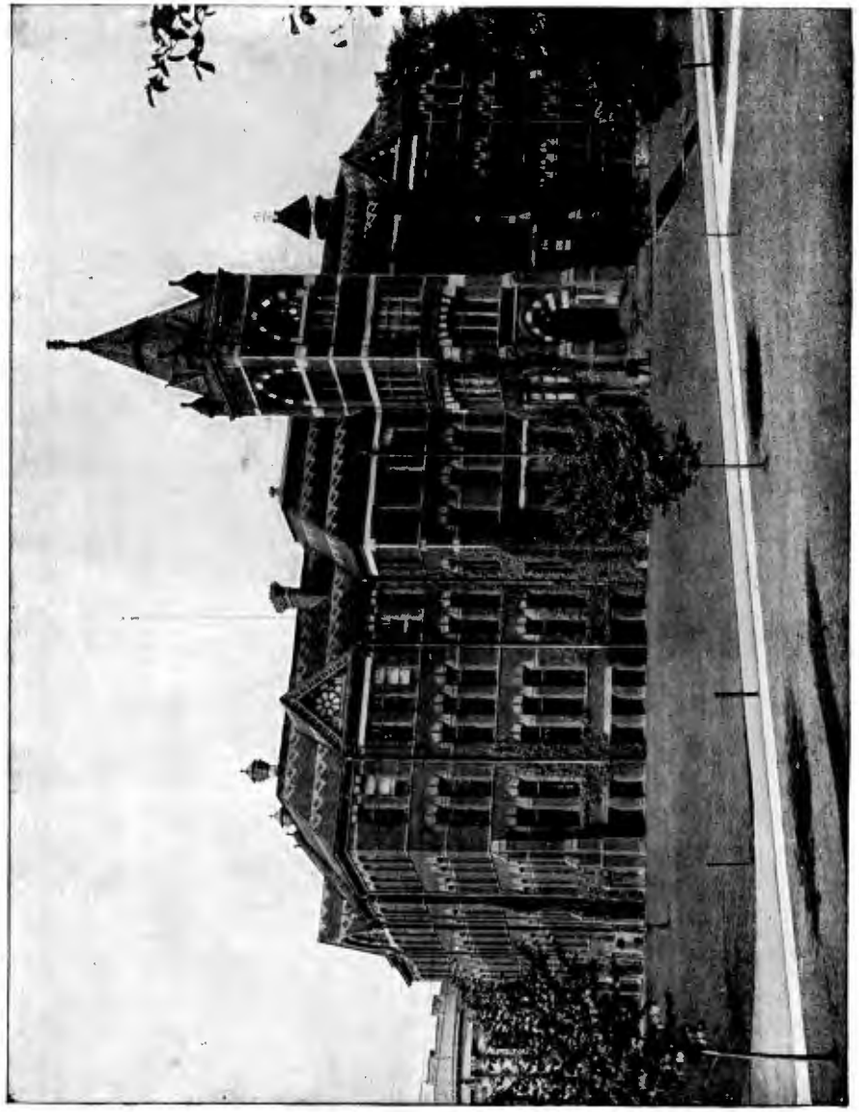

THE LITTLE RED SCHOOL HOUSE

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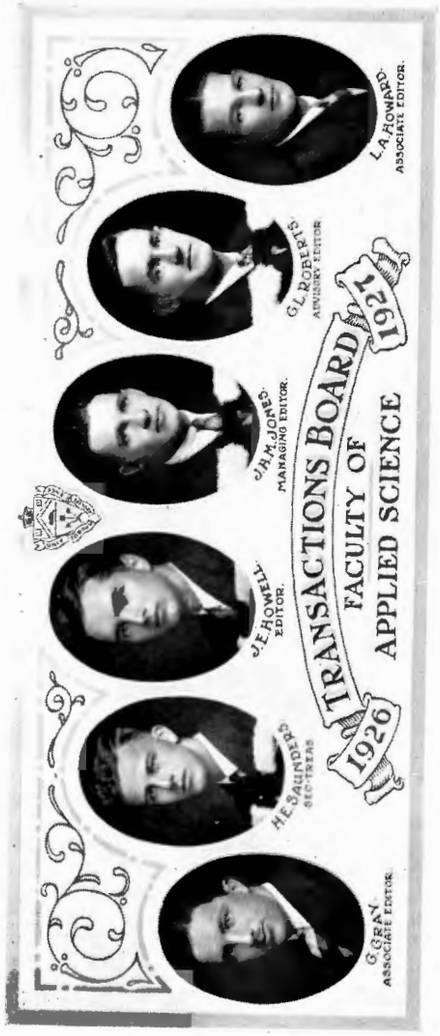


Transactions and Year Book

of the

University of Toronto Engineering Society

With which is incorporated "Applied Science"

PUBLISHED ANNUALLY BY THE SOCIETY

No. 40 TORONTO, APRIL, 1927 Price 50c

Editorial

Since there is no clearly defined policy for this publication—contents, appearance and all details being left entirely to the discretion of the board—we find it unnecessary, thank Heaven, to explain or justify in this editorial the part or parts of this volume which may call forth criticism or comment, either because they are included, or because they are not. Let it merely be stated that the editors have attempted to make the TRANSACTIONS as interesting to read as possible—interesting to the undergraduates as well as to the alumni; and that, if they succeed in having every word of this publication read by all School men, they will deem their work well rewarded.

It will be noted that the only address to the Engineering Society printed in this issue is the one by Dean Mitchell on the St. Lawrence Waterway Problem. This subject has elicited so much discussion during the past few years that an exposé by one who is so intimately acquainted with all its difficulties and all its possibilities will not fail to interest a large portion of TRANSACTIONS readers.

There were other very interesting addresses delivered before the Engineering Society, but they dealt either with very specialized subjects, of direct concern only to a small portion of the students and alumni, or they took the form of undisguised advertising talks which were very interesting indeed, but whose inclusion in

TRANSACTIONS would savour too much of free publicity. The loss is ours, since these lectures and addresses were well worth hearing. And we hope that, in the future, means may be found to surmount these difficulties.

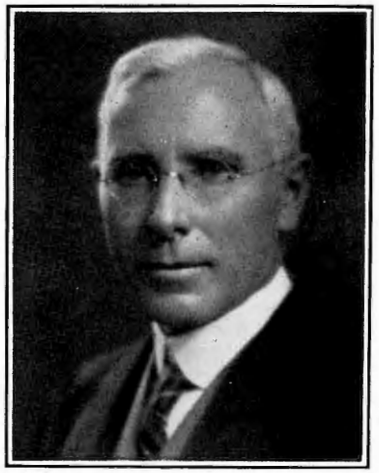
Mr. D. S. Lloyd's paper on the application of the oxy-acetelene flame in all phases of industry was specially written for TRANSACTIONS. It deserves the attention of all students, as it shows what amount of experience the young graduate can accumulate in a comparatively short time; and it will perhaps indicate to graduates uses for this process which had not hitherto occurred to them.

Mr. Howarth was kind enough to permit the publication of some of the results of his original research work on lubrication. The TRANSACTIONS board wishes to thank Mr. Howarth for this valuable contribution, and also Professor Angus for attracting the editors' attention to the value of this paper, and for procuring the copy.

G. L. DeLaplante's thesis on "Methods of Improving the Efficiencies and Powers of Motor Car Engines" was awarded the first prize for student papers by the Toronto Branch of the American Society of Mechanical Engineers (A.S.M.E.). The paper contains an impartial résumé of the most modern methods employed in this field, and of some of the principles involved.

The hundredth birthday of the University of Toronto is an event which will be celebrated this year, together with the fiftieth birthday of "School." Preparations have been made to ensure the success of the various functions which will mark these joyful occasions. Professor C. H. C. Wright, of the class of '88, has kindly consented to write for the YEAR BOOK an authentic account of the circumstances which led to the establishment of the School of Practical Science; of the difficulties encountered in the early days when "applied" science was something unheard of in an academic curriculum; and of the debt which all School men—and the country at large—owe to that courageous pioneer of technical education in Canada: Dean John Galbraith.

The Board of Editors wish to express their sincere gratitude for the generous help which they have received from faculty and students in the publication of this annual.



The Dean's Message for 1927

To the Class of 1927,

Faculty of Applied Science and Engineering.

Gentlemen:

You are indeed fortunate in graduating from the University this year!

The year 1927 will go down in the history of the University and the Country as a radiant one.

It is the Centenary year of the University and we celebrate all which that means, counting all the years of this great University so full of history.

It is the Diamond Jubilee of Canada and the Confederation, which has carried Canada along this radiant path of nationhood.

It is the Semi-Centennial year of the Faculty of Applied Science and Engineering. The Jubilee of the "Old School," carrying the red mark of the "Old Red School House" which is indelibly printed everywhere in the country by its graduates.

It is *your* year, your graduating year, the year you will always look back to as the proudest of your life. It is your commencement year, when you commence as engineers and set out on your careers in this favoured country.

What a "jumping off place" this 1927 year is! We have been talking prosperity as a possibility the past few months, and now

it is here. It is unmistakably here and you are about to be thrown out of the University into it!

I ask you, in a parting message, to realize how fortunate you are to be living this year and to be graduating this year, and I am sure you will carry out into the world that cheerful optimism, that citizenship and comradeship and that "will to win" which has always marked the "School" man the past half century.

Best success and good fortune to you all.

Yours faithfully,

C. H. MITCHELL,
Dean.

Address of Retiring President

Fellow School Men:—

It is time for me to retire. Before doing so, however, I would like to express my appreciation of the honour which I have experienced in being elected to and in holding the office of President of our Undergraduate Engineering Society. It has been a very great pleasure to be in a position to serve our Society to the very best of my ability. In some cases my ability has probably been found wanting, but supreme pleasure is mine in realizing that I have done my best.

Right now I wish to remind you that the President does not run the Society. I have had behind me a hard working and steady executive and the whole-hearted support of other members who were only too willing to offer any assistance whatsoever. May I just mention a few of the outstanding: Al. Lee, Charlie Morrison, Aub. Sievert; these men, though always busy, were never too busy to do a turn for our Society, upholding a saying that "When you want something done, go to a busy man and he'll do it."

In reference to the financial statement of the Society, detailed elsewhere in this publication, I may well remark that it might have been worse. But that is not an encouraging term and is not intended as such. The financial statement is as favourable as it is only because of much gruelling over many small items which amount up to many dollars. The sales of our supply department are dropping off annually, and not because of decreased registration but largely because of the decrease in popularity of our supply department—supplies and prices are as good value as before, as wide a range as before. Our difficulty is this—our supply department room was once the centre of attraction of every member of the Society; in other words, it was a rendezvous, and as such prospered from transient trade. As a reason for the difference mentioned I refer you to an article in this publication entitled, "School Sayings and Toike Topics."

In regard to the regular meetings of the Society I believe that the apparent lack of enthusiasm may well be explained. This is an age of specialization, and as such is unfortunate to us students in this particular stage of our education. Our duty to ourselves and to the world is to grasp a broad glimpse of fundamentals, and in "School" those fundamentals should pertain to Engineering as a science. Engineering as a profession comes after College days are over, and then is the time to specialize in that line which appeals to us most. Have we not been leaning towards specialization during our College days, and if so is that not the reason for the lack of general interest in any Engineering topic as discussed at our regular meetings? Possibly our curriculum is at fault, tempting us to become specialists; possibly we must be specialists to pass the examinations as set by our respective departments; I prefer not to agree with any of these possibilities, because if a man is old enough and has the qualifications for registration he should be well enough balanced to control his personal tendencies and govern his actions accordingly.

Upon occasion I have been ashamed to invite a prominent Engineer, an authority in his particular line, to spend time, money and energy and

then address an assembly of fifty men as a representative audience of our Society membership. But then there is a "come-back"; if the speaker is not a man of distinction, students say that they will not attend the meeting. Now let me ask you, is your President to act on principle and cater to a few at the expense of the reputation of the Society and his own embarrassment, or is he to save himself embarrassment and attempt to keep the Society reputation from authoritative circles and cater to a still smaller representation of the Society membership?

"All is not gold that glitters." I did not expect to find the President's duties light; they aren't.

And now let me present your new President, Bill Duncan; may he and his executive receive your whole-hearted and individual support.

The Centenary next Fall calls for the co-operation of every student; you owe it to your University, your Faculty and to yourself.

I wish you all a most successful year. Don't think me unkind or otherwise objectionable for anything which appears in this my last message. I have the best interests of our Society at heart, and who knows, maybe they are at stake? I refuse, absolutely, to believe our Society to be in decline, and with the deserving support of you, its members, it will continue to thrive as the centre of "School" activities.

Yours most sincerely,

T. W. E. Bingham.

THE TRANSACTIONS
OF THE
University of Toronto
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WITH WHICH IS INCORPORATED THE "APPLIED SCIENCE"

No. 40 TORONTO, APRIL, 1927 Price 50c.

Problems of the St. Lawrence and the Great Lakes*

By Brig.-General C. H. Mitchell, C.B., C.M.G., C.E.,
Dean of the Faculty of Applied Science and Engineering.

I propose to lay before you certain problems of the Great Lakes and the St. Lawrence River. In contemplating these problems you will see what these lakes and the St. Lawrence mean to our country and to the United States in their various aspects.

The aspects which we naturally consider divide themselves into:—

1. Geographical: Take the map of this Continent—here on the wall you have the map of Canada—and you will readily see how from the Atlantic, the Gulf of St. Lawrence, the River and the Great Lakes form a continuous channel penetrating into the very heart of the continent. You will see how the Gulf empties out far into the Atlantic much nearer Europe than is any other part of America.
2. Physical: Look at the shape and arrangement of the Great Lakes. The largest at the top—at the interior—and the smallest at the lower end, near the outlet. The total fall of 600 feet from Lake Superior and the 245 feet from Lake Ontario to the sea. Nowhere in the world is there such an expanse of lakes situated at a high level above the sea.
3. Economical: The economical possibilities form perhaps the most striking aspect. Not only is this a great body of fresh water supplying and draining a continent but it offers at the same time a great navigation sea-way and a great source of power, unparallelled in the world.

*Delivered before the Engineering Society, October 20, 1926.

4. Commercial: If we consider the possibilities of trade and commerce which have been and can be developed around the shores of the lakes and down the river to the sea and if we could conceive it as fully developed in the future, it would have a very great influence on the trade not only of the continent but of the world.

5. Financial: When we have presented the economical and commercial aspects we begin to realize what it means to finance the full development of these lakes and the river. Conceive the vast amount of money that has already been invested in, upon and on the shores of the Great Lakes and their connecting rivers. Then consider how much more is necessary to complete these to their fullest possibilities in all the various phases of investment—municipal, transportation, power and industry.

6. Technical: This, though most important to us as engineers, I have placed last, so that the full significance of the relation of engineering to the other aspects can better be appreciated. Obviously the engineering problems involved in all these aspects and the projects and developments on the Great Lakes are far-reaching, various, and in many cases very complex. These are the things which Canadian engineers have been called upon to deal with, and will in the approaching years still more demand their ability and co-operation not only with each other but with the different interests which are involved.

The St. Lawrence River has a thousand miles of smooth water from the head of national navigation, to the sea. The Great Lakes System add another fifteen hundred miles of water route to the very centre of the continent. This is, in effect, an American Mediterranean and similarly gives access to regions of vast wealth. It so happens that the Mediterranean extends just the same distance inland from the Atlantic.

With the Gulf of St. Lawrence protruding out into the Atlantic alongside of Newfoundland, the distance across the open sea to England and Europe generally forms by far the shortest Transatlantic crossing. Some of our Canadian shipping companies effectively advertise for passengers with the slogan "Only four days at sea." From my personal observation I know the advantage in this respect of the St. Lawrence route compared with the longer sea crossing from New York.

From the point of view of power the St. Lawrence River is unique. The supply of water from the Great Lakes forms a steady source. The discharge from Lake Superior is regulated at Sault Ste. Marie between 60,000 and 100,000 cubic feet per second. The normal discharge from Lake Erie varies at Niagara Falls between 180,000 and 200,000 cubic feet. That down the St. Lawrence is usually between 200,000 and 250,000 cubic feet per second.

On this basis, the St. Lawrence River with its 225 feet fall from Lake Ontario to Montreal, can produce a total of from 4½ to 5 million horsepower, a truly large amount.

An interesting feature about the Great Lakes as a whole is the fact that they not only form a very large area as a watershed, but comprise an exceptionally large area in water surface. There are about 305,000 square miles in the St. Lawrence water basin including land and water. Of this, a little over half is in the U.S. Of this total area, about 95,000 square miles is water surface.

This brings in two or three things from a hydraulic point of view. There is the actual supply of water from the various sources, the principal of which are the rivers and tributaries, which in turn are supplied by the rainfall on the land. There is also the additional source of the actual rainfall on the water surface. The former source comprises what comes to the Great Lakes in the form of run-off, which, as is well known, is variable in different localities, but may be, say, half of the total rainfall. On the other hand, the rain falling on the actual water surface of the lakes is all caught by them and thus forms a very large factor in the total water supply.

Another important feature in the supply is on the other side of the ledger, being the evaporation off the surface of the lakes. This is very great, much greater than is commonly supposed, and forms the largest factor among the various diversions from the lakes. The water supply out of the lakes and available down the St. Lawrence varies directly as the rainfall on the drainage area, which is quite fluctuating, and of recent years has been less than the average.

These two features constitute the largest causes in the lowering of the lake levels, of which much has been said in recent years. Precipitation is intermittent but evaporation is constant. Therefore if the season be dry and warm, that is, small rainfall and large evaporation, the lakes will fall. If, on the other hand, it be wet and cold, that is, large rainfall and less evaporation, the lakes will rise.

A feature of the power supply from the St. Lawrence is its great uniformity. This is easily the steadiest flowing river in the world; no other can approach it. This is, of course, due to the Great Lakes acting as natural reservoirs or regulating basins. As I have indicated, the supply and the discharge from the lakes may be affected by the variable rainfall and the climatic conditions; but, notwithstanding these, the discharge at the lower end of the system attains great regularity, as the divergent factors seem, more or less, to balance each other throughout the seasons and years. Most of our large rivers hereabouts have a ratio of low or dry weather-flow to high or flood flow of about 1 to 10 or 1 to 20. The St. Lawrence has a ratio of about 1 to 1.7, which is so low as to put it entirely in a class by itself in the world.

One of the great problems in connection with the Great Lakes is that of their regulation or maintenance of their levels, especially in view of the tendencies to lower them. This has engaged the attention of engineers for years.

Their problem with reference to Lake Superior has been solved by the insertion of a control or regulating dam at Sault Ste. Marie, which is operated by the two countries under a Control Board. This is not so easy, however, with respect to Lakes Huron, Michigan and Erie. There is considerable difference of opinion how these can be controlled, one side favouring "compensation" by which the lakes are permanently held at a higher level, by choking the outlets, and the other favouring "regulation" by dams and sluices. The latter, of course, would form an obstruction to navigation, and thus has objections. Generally speaking, the lakes, with reference to each other, form the most sensitive kind of balance that can be imagined, and anything done to interfere with this must be conceived and carried out with the greatest care.

Lake Ontario, the lowest of the series, can readily be controlled by a dam on the St. Lawrence, and this process would naturally be followed, if and when the St. Lawrence River is developed or "improved" for navigation and power.

The St. Lawrence River itself presents many problems. If the proposals which are now under discussion, and which I may, at a later date, be more free to describe, are undertaken, the prospect of navigation and power will comprise engineering problems of a magnitude far beyond any previously approached.

The dams necessary to control this huge river would not only in themselves be among the greatest of the world, but their construction would involve operations in the diversion and handling of water four or five times greater in volume than has hitherto been attempted, and that, too, without the advantage of low water seasons.

As for the navigation works, they would, when built, be greater in some of their features even than those of the Panama Canal. At the present time the new Welland Canal is the greatest engineering work of a general kind now under construction, and of it Canada is justly proud. The locks, while not as long, wide or deep as the Panama, have greater lifts, and will overcome a height several times greater. If the St. Lawrence locks and canals are built of the same size as the Welland, the whole series of canals and waterways, with an additional 100 miles of improved river waterway, and with a total rise of 225 feet, would easily be the largest canal undertaking in the world.

Another constructional problem is that of keeping the present navigation in operation while the new works are being built. This is no easy matter with the large number of vessels and the enormous dimensions of the river. It has been estimated that the navigation works would take from eight to ten years to complete.

Perhaps the greatest problems, however, arise from severe Winter conditions and the ice difficulties. These have no relation to the navigation, except of course for the construction operations. But with respect to power operation they are most vital, and it is essential that correct solutions be secured for the many and varied problems which winters of different intensities, lengths and character present. It is sufficient to remind you that the St. Lawrence River is a huge ice manufacturing plant and that freedom from ice difficulties is essential to hydro-electric power works.

The actual problems with respect to ice are unique as they are on all northern rivers, and especially on rivers flowing northward as does the St. Lawrence. The upper stretches of the river free themselves of ice earlier in the Spring, especially when warm water comes out of Lake Ontario and the Ottawa River. The accumulated ice below, however, offers an obstruction to the free passage of water, and hence the Spring ice jams and floods occur at various points, especially at Montreal. In the same manner, when the ice is forming in the early Winter, obstructions occur by newly formed ice "bridging" and packing upstream or forming "hanging dams" of ice which build downward and thus restrict the free water channels underneath.

These all bring curious and very special hydraulic problems which engineers are called upon to meet; for these involve velocities and cross sections and changing hydraulic radii, all of which have their peculiar characteristics. It is of interest to note that if the water velocity is kept down to about 2.25 feet per second, broken and floating slush and frazil will quietly pack upstream, forming an ice cover; but, if the velocity is increased to three feet or more, it will be carried under and form a hanging dam and thus restrict the channel. When the latter happens, the velocity of course increases and aggravates the situation, while ultimately the water dams up and floods back, the river readjusts itself at a new level, and in due course the same process may be repeated.

The project now under discussion for the great St. Lawrence waterway will shortly claim considerable attention; while, in this address, I have confined myself to telling you some of the characteristics and problems of the lakes, it may be useful to you to have some outline of the arguments which are being put forward for and against undertaking this huge project controlling the lakes and developing the St. Lawrence River for navigation and power. I am not at present at liberty to discuss details or proposals, nor am I free to advance arguments in either direction, but I give below some of these which are being put forward by others who are interested parties:—

In opposition to the project the following are among the principal arguments:—

1. That the huge cost of the project is beyond Canada's means at the present time, especially with our burden of railway and war debt.
2. That the time is not opportune for embarking on a new navigation project.
3. That new traffic will not, and possibly cannot, develop in such degree as to justify such an ambitious undertaking.
4. That the navigation season of 7½ months is too short and will seriously deter trade.
5. That the ocean ships will not come up the river into the lakes.
6. That by reason of the canalization and restricted channels, speeds will be very much reduced and valuable time lost.
7. That Great Lakes and St. Lawrence navigation will seriously compete with our great railways which are so essential to the country's development. It is asked why create a new competitor to the Canadian National Railway?

In favour of the development of the project the following arguments are advanced by those interested:—

1. That the cost is not abnormal for Canada, especially as the Dominion would be concerned only with that for navigation. Power costs would take care of themselves. Some go so far as to advocate that power should help pay for navigation.
2. That the time is opportune to embark in improved navigation of Lakes and St. Lawrence. The country cannot hold back, but must now take another step in the process of enlargement.
3. That the great volume of business and the rapid rise of the Port of Montreal indicate the possibilities and importance of this route. It is now second only to the Port of New York on the Atlantic Coast in volume of business.
4. That water transport all over the world, shows that in countries rich in resources, ocean vessels will readily go inland as far as possible to secure trade.
5. That the inland portion of Canada, especially around and beyond the Great Lakes, is one of the richest in those resources of a character which require cheap transportation.
6. That the present ocean ships can easily come up insofar as draft is concerned. According to Lloyd's Register about 70 per cent of the freight vessels of the world could come up at 25 feet draft, 80 per cent at 27 feet draft, and 90 per cent at 30 feet.
7. That navigation through restricted channels is not as serious as represented; speeds will be reduced as compared with open water, but not more than in ordinary wide river navigation, except in canals and locks, which would consume but little time.
8. That a 7½ months' season is not a serious deterrent. All ocean trade is seasonal except on a few regular lines to large ports.

9. That the railways of Canada will not suffer. The Canadian Pacific and the Canadian National are both in the lake and ocean navigation business themselves and could quickly take advantage of the opening of the Great Lakes. The water routes would quickly become adjuncts of the present railway systems, and with an increase of water borne trade on the Lakes, the Railways are bound to profit by co-operation on land.
10. That with respect to Power, there is such a demand within transmission distance of the St. Lawrence as to urge some kind of development at the earliest possible date.

Viscous Friction in Bearings*

By H. A. S. Howarth

General Manager and Chief Engineer, Kingsbury Machine Works, Philadelphia, Pa.

In this talk I am going to try to place before you a few fundamental ideas on the subject of viscous friction in bearings. In order that you may visualize what actually takes place in the lubricating film, I have prepared a number of slides which, it is hoped, will make the subject clear to you. Viscous flow may be thought of as straight line flow or a flow that is free from whirls and eddies. If oil flows through a small straight tube all particles will move in straight lines parallel to the axis of the tube. If oil flows between flat fixed parallel plates all particles will move in straight lines parallel to each other and to the adjacent surfaces of the plates.

Within the tube the points lying in a cylindrical surface concentric with the tube bore will all move with the same velocity and in the same direction if the tube has a uniform bore. Points on concentric cylindrical surfaces with different diameters will not move at the same speed. Flow along the axis will be the most rapid, and the rate of flow will decrease as the bore of the tube is approached, reaching zero at its surface.

Similarly, with parallel plates, flow along the middle plane between the plates will be the most rapid and this rate of flow will decrease as the plate surfaces are approached. If the plates are fixed there will be two planes, one on each side of the middle plane, in which the rates of flow are the same. These will be equally distant from the middle plane.

The rate of flow at the surfaces of the plates will be zero. In other words, the lubricant is assumed to adhere to the plate and tube surfaces, so that the only motion that takes place adjacent to their surfaces is the distortion of the lubricant itself.

This distortion of the lubricant may be pictured by assuming the film made up of innumerable parallel layers which slide on each other.

Fig. 1 illustrates a small portion of such a lubricating film, chosen anywhere, with the limitation that the imaginary parallel boundary surfaces at the top and bottom lie in the direction of relative motion within the film. The distance between these imaginary planes is infinitesimal and is therefore represented by dy.

The area of each surface of this small portion is assumed to be one square unit. The velocity of the lower surface is represented by u. The velocity of the upper surface is assumed to be greater

*A paper read before the Ontario Section, American Society of Mechanical Engineers, in Toronto, January 11th, 1927.

than that of the lower surface by an infinitesimal amount du. If the lower surface is then assumed stationary, the velocity of the upper will be du.

A velocity diagram of the lubricant between two surfaces is represented in Fig. 2. Point C has zero velocity and point D has a velocity du which is laid off to the length DG. Connecting G to C and D to C we have a triangular diagram from which we can determine the velocity at any other point E between C and D. The line EF represents the velocity at a distance EC from C. By similar triangles velocity DG divided by velocity EF = distance DC divided by distance EC.

The effect of pressure variations upon this relation is very considerable, but so long as the film as a whole, whose thickness is finite, is unaffected by internal variations in pressure, its internal velocities will vary as illustrated in Fig. 2.

In order that the upper surface of Fig. 1 may be moved with a velocity du with respect to the lower surface a certain force, f, per unit area, must be applied continuously. The ratio of the velocity it produces to the distance between the surfaces, that is, du/dy, is called the rate of distortion.

If we compare the force f, with the rate of distortion it produces, we have a means of comparing one kind of lubricant with another. The more viscous the lubricant is, the greater is the force per unit area required to produce in it a given rate of distortion.

The ratio of this force to the rate of distortion which it produces is called the absolute viscosity of the lubricant. It has been adopted as the fundamental basis for making viscosity computations and comparisons. This absolute viscosity is represented by the Greek letter μ, called the coefficient of viscosity. $\mu = f/\frac{du}{dy}$. The symbols employed in this paper are those used by Osborne Reynolds, and William J. Harrison.

Parallel plates, may be assumed to be a distance h apart, and relatively fixed. Lubricant is placed between them. This is next subjected to a pressure, not by the plates but by some external force applied directly to the edge of the lubricating film, as by compressed air.

Fig. 3 shows the plates CD and EF in the horizontal position. If the pressure applied at one edge of the film CE is greater than the pressure at the opposite edge DF there will be a flow from CE toward DF. If the pressure drop between these edges is maintained constant the flow will remain constant, provided also that the viscosity of the lubricant does not change.

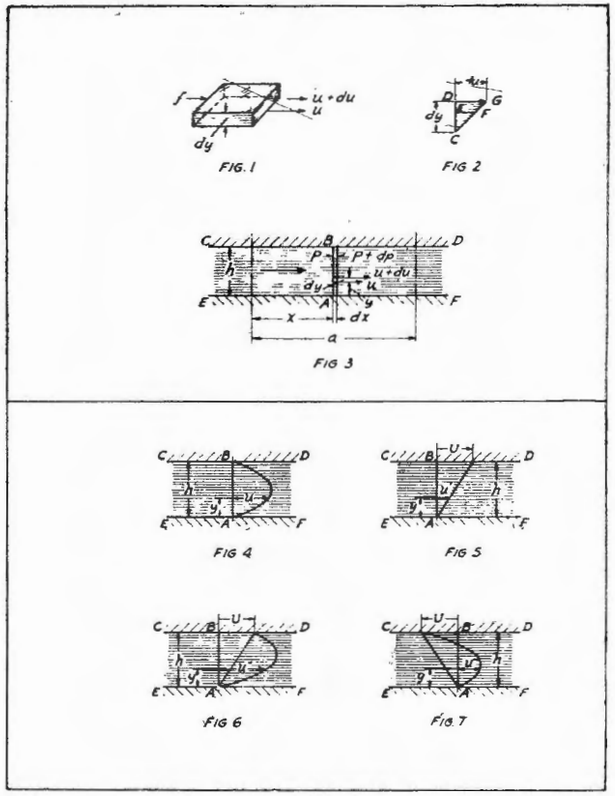
Let P represent the internal pressure at a vertical plane AB, at a distance x from a reference plane, both of which are perpendicular to the direction of flow and also to the two fixed plane surfaces CD and EF.

In another plane at distance dx from plane AB the pressure will differ from the first by a differential amount, dp. In the figure it is marked $P + dp$ because the position of the plane is

$x + dx$. In making calculations involving these quantities it might be found that the actual sign of dp is:—

In a plane within the film of Fig. 3, at distance y up from surface EF, and parallel to it, the velocity is represented by u. In another plane at distance $y + dy$ from EF the velocity will be $u + du$.

These notations are illustrated in Fig. 3, which therefore shows the set-up for the mathematical determination of the transverse



velocity variation between the two surfaces EF and CD, and also of the rate of flow along the space between them.

The set-up is the same whether Fig. 3 represents a section of two parallel plates or the section of the bore of a tube.

For parallel plates the force which acts at distance y from EF to produce the velocity u equals $dF = \frac{b}{2}(h\text{-}2y)\ dp$. This can easily be shown to lead to the following formula, $V_p = \frac{P\ b\ h^3\ t}{12\ \mu\ a}$*, which gives the volume of flow, in time t, of the lubricant between two

fixed parallel plates at distance h apart, when the lubricant is acted upon by an external pressure P.

The length of the plates in the direction of flow is represented by a. The rate of pressure drop is therefore P/a. The width of the plates perpendicular to the direction of flow is represented by b. The plates are assumed to be closed at the sides, and the influence of these sides upon the rate of flow is neglected.

This same set-up, Fig. 3, may be used to determine the rate of flow through a cylindrical tube, diameter h and length a. In this case the force which acts upon the surface of a cylindrical portion distance y from the inner surface of the tube and which produces at that point a velocity u is $dF = \frac{\pi}{4}(h\text{-}2y)^2\ dp$. The volume of flow through a tube of length a can therefore be expressed as follows: $V_t = \frac{\pi\ p\ t\ h^4}{128\ \mu\ a}$.*

The variation of velocity between the surfaces CD and EF should be examined, and assuming them to be parallel plane surfaces, we find as stated before, that half way across, the velocity is the maximum—that it is zero at the two surfaces—and also that the relation between the velocities and distances from the surfaces is parabolic.

In Fig. 4 this relation is illustrated by the parabola drawn upon the base AB. At a distance y from EF the velocity is u. The rate of distortion, *i.e.* the rate of change in velocity, at that position is $\frac{du}{dy}$ which graphically may be represented by a tangent to the velocity curve.

The equation of velocity variation for fixed parallel plates is found to be as follows: $u = \frac{P}{2\mu a}(hy\text{-}y^2)$. The corresponding formula for a tube is as follows: $\mu = \frac{P}{4\mu a}(hy\text{-}y^2.)$

Let it next be assumed that there is no pressure acting upon the film between parallel plates EF and CD in Fig. 5, but that the plate CD has a velocity to the right equal to U with respect to EF.

The film in contact with CD therefore moves with velocity U while that in contact with EF is relatively stationary, with a velocity of O. At any plane surface at distance y from EF the velocity of the film is u'. The relation between the velocities is $\frac{u'}{y} = \frac{U}{h}$.

This triangular relation of velocities within the film between EF and CD holds for a bearing film at points where there is no variation of pressure, *i.e.* at the points of maximum and minimum pressures, where $\frac{dp}{dx} = O$.

*These check with Archbutt-Deeley.

Let us assume that a pressure acts upon the film causing it to flow as in Fig. 4 and that at the same time the surface CD moves relative to EF with a velocity U. The velocity of flow within the film may be represented by superimposing the parabola of Fig. 4 upon the diagonal line of Fig. 5 as illustrated in Fig. 6, in which the direction of flow due to pressure is assumed to be the same as the direction of motion of the surface CD. The distances from the vertical to the curve show film velocities relative to the fixed plate.

It is quite possible, however, that the direction of flow due to pressure will be opposite to that caused by motion of the surface CD.

In this case the pressure diagram of Fig. 4 must be superimposed up a diagonal line like Fig. 5 at the left of AB. This is illustrated in Fig. 7. For the magnitudes assumed the velocity varies from zero to a positive maximum, and then through zero to a negative maximum.

Referring again to the formula for the viscosity we may rearrange it as follows: $f=\mu\left(\frac{du}{dy}\right)$. In other words, the force per unit area required to produce a given rate of distortion $\frac{du}{dy}$ is equal to the product of that rate of distortion into the coefficient of viscosity of the lubricant.

Since the rate of distortion is illustrated in Figs. 4, 6 and 7 by the tangent to the velocity curve it is evident that the force f will vary from EF to CD. In Fig. 4, in which the two surfaces EF and CD are fixed, the rate of distortion $\frac{du}{du}$ will have the same arithmetical value at A and at B.

This value will decrease as the point of tangency moves along the curve to the middle plane, at which it becomes zero. Referring now to Fig. 6, the slope of the tangent to the velocity curve will be greater for A than for B. In other words, the force required to produce the distortion at the moving surface will be less than at the fixed surface, when the pressure within the film causes the lubricant to flow in the direction of the moving surface.

In Fig. 7 the slope of the tangent for point A is less than its slope for B, hence the force which produces the distortion within the film will be greater at the moving surface than at the fixed surface when the flow produced by the pressure within the film is opposite to the direction of the moving surface.

The flow of oil within a bearing film can be studied, taking first the simplest case, in which the journal is completely surrounded by the bearing, as illustrated in Fig. 8.

The theory of lubrication as developed by Osborne Reynolds, when applied to a full bearing by Wm. J. Harrison, showed that, when the lubricating film is complete, and end leakage is negligible as it would be in a relatively long bearing, the revolving journal

assumes an eccentric position in which the diameter through the centres is perpendicular to the direction of the applied load.

Measuring the angles as in trigonometry with 0° at the right, the rotation of the journal is assumed to be counter-clockwise, i.e. in the direction of the increasing angle.

This arrangement has been found mathematically to bring the point of nearest approach at 180°, the maximum pressure beyond 90° and the minimum pressure symetrically below the 0° – 180° axis. The pressures at 0° and 180° are the same and are represented by P_0. R represents the load applied to the bearing along the line through its axis.

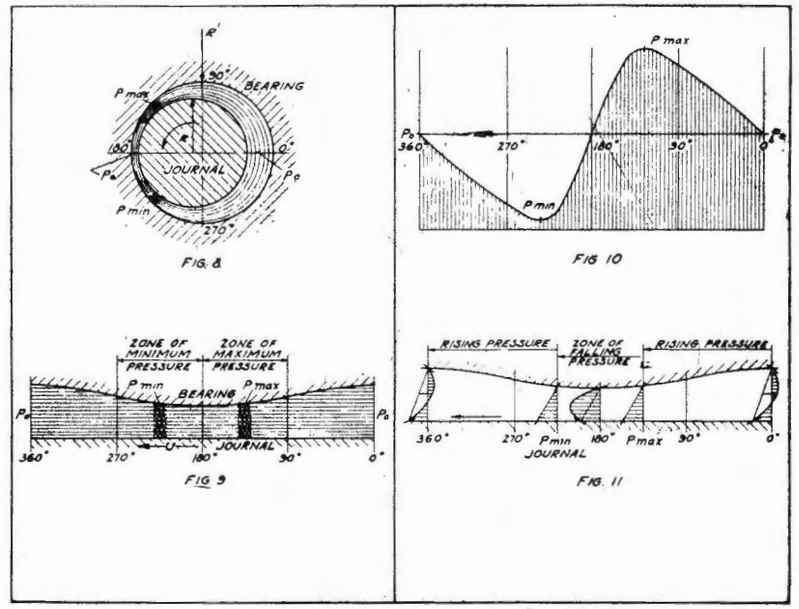


Fig. 9 shows a developed cross section of the film in this bearing, with the journal surface represented by a straight line, and the bearing by a sine curve. The zones of maximum and minimum pressure are also shown in this figure. The point of maximum pressure is always between 90° and 180°. Hence it always occurs before the point of nearest approach is reached.

The point of minimum pressure always lies between 180° and 270°. Thus, it always occurs after the point of nearest approach has been passed. This statement is always true for bearings in which there is both a minimum and maximum pressure, one below and the other above P_0.

It can be shown that when the applied load is 0 the journal and bearing axes coincide, and that as the load increases the dis-

tance of nearest approach varies from the radial clearance to zero. The point of maximum pressure for a small load is just beyond 90°.

As the load increases, the point of maximum pressure moves around, reaching 180° when the load and pressure become infinite. The point of minimum pressure is always symmetrically located about the line of centers, with respect to the point of maximum pressure.

The pressure that is generated within the lubricating film of a revolving journal surrounded by a full bearing is illustrated in Fig. 10. This pressure diagram is drawn directly over Fig. 11, which shows the developed film, in order that the change in pressure may be compared with the change in film thickness

These figures are drawn for an eccentricity of about twenty per cent. The characters of the curves vary with the eccentricity and not only do the points of maximum and minimum pressure change their positions but the magnitudes of the pressures increase with the eccentricity.

The velocities within the film are indicated in Fig. 11 which shows how they depend upon the changes in pressure within the film. At the points of maximum and minimum pressures the rate of change in velocity is zero; that is, $\frac{dp}{dx} = O$. As there are no changes in pressure at those points the only velocity in the oil there, will be due to the relative movement of the bearing surfaces themselves.

The velocity diagrams for these portions of the film can therefore be represented by triangles as first illustrated by Fig. 5. Between the points of maximum and minimum pressure the flow of oil will be toward the left in Fig. 11, that is, in the direction of the pressure drop.

The curve representing velocity variation across the film will therefore be like that previously illustrated by Fig. 6.

After the point of minimum pressure is reached the pressure will increase to P_0 at 360° and continue to increase beyond 0° from P_0 to *Pmax*. In this zone of rising pressure the flow of oil due to pressure will be opposite to the direction of motion of the journal.

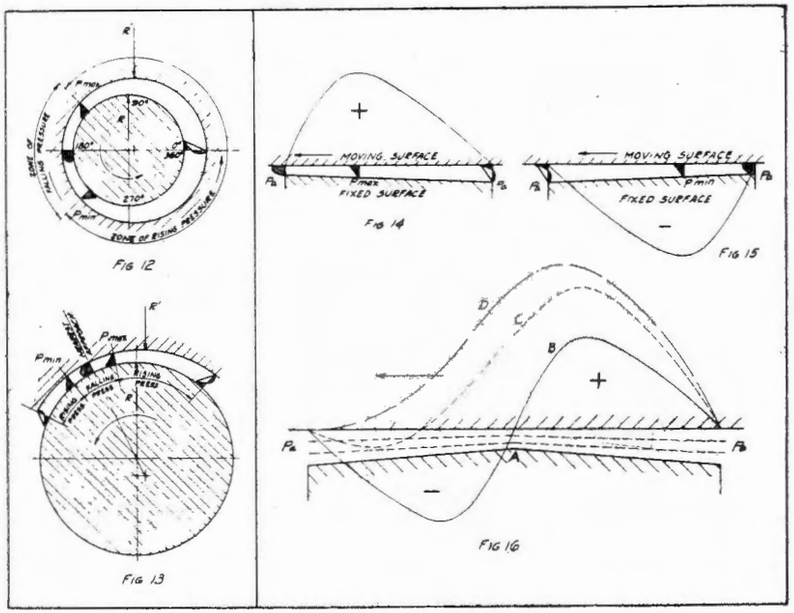
In this zone therefore the curve representing the velocity variation across the film will resemble that previously illustrated by Fig. 7.

These curves of velocity variation, illustrated for the developed film in Fig. 11, are shown within the undeveloped film in Fig. 12. The forward flow due to pressure drop is always in the direction of falling pressure. At the point of nearest approach this flow corresponds with the direction of rotation of the journal. At the point of greatest separation of the surfaces this flow is opposite to the direction of motion of the journal.

These velocity variation curves can be plotted for any sections of the film. For other points between *Pmax* and *Pmin* in the direction of rotation they will have the general character of the curve at the point of nearest approach.

Between *Pmin* and *Pmax* in the direction of rotation they will have the general character of the curve at the point of greatest separation. This flow of oil within the film has a large influence upon the friction.

In the partial bearing illustrated by Fig. 13, the point of nearest approach is assumed to be to the left of the vertical in the direction of rotation. The load applied to the partial bearing is *R'* acting vertically through the center of curvature of the bearing.



In this partial bearing, just as in the full bearing, the radius of the bearing is slightly greater than the radius of the journal by an amount *n*, which is the radial clearance. The point of maximum pressure occurs before the point of nearest approach is reached, just as it does in a full bearing.

If the partial bearing extends sufficiently far beyond the point of nearest approach there will be a region of sub-atmospheric pressure whose minimum will be located symmetrically with the maximum about the line of centers, which passes through the point of nearest approach.

In the bearing illustrated there is a zone of rising pressure beginning at the right end of the bearing, in which the pressure rises from atmospheric to *Pmax*.

Between *Pmax* and *Pmin* there is a zone of falling pressure in which it drops from *Pmax* through atmospheric to *Pmin* which is below atmospheric. Beyond *Pmin* to the end of the bearing is the

zone of rising pressure in which it increases from *Pmin* to atmospheric. It should be borne in mind that not all partial bearings run with pressures below atmospheric on the trailing edge. The best of them have no negative pressures.

For a given finite load, with zero *r.p.m.* the point of nearest approach in a partial bearing would be where *R'* cuts the bearing surface. As the journal begins to turn, the fluid film forms which separates the surfaces more and more completely as the speed increases.

The intersection between line of centers and the bearing surface, as the speed increases, moves along the bearing surface in the direction of rotation of the journal, even passing the end of the bearing for certain combinations of load and speed and resultant position. The velocities within the film of the partial bearing are shown in Fig. 13 to be similar in character to those for the full bearing.

Referring to Figs. 12 and 13, showing the sections of the film for a full and a partial bearing, it will be noted that the minimum pressure occurs where the film thickness is decreasing in the direction pressure occurs where the film thickness is decreasing in the direction of motion of the journal, whereas the zone of minimum pressure occurs where the thickness of the film is increasing in the direction of motion of the journal.

Hence this law may be stated. In order that a bearing may generate a pressure within its film greater than that at which the oil enters the film at the edge of the bearing the film must be wedge-shaped with the thin end pointing in the direction of rotation of the journal.

Conversely, in order that a pressure below that of the entering oil may be generated the film must be wedge-shaped with the thin end pointing in the direction opposite to the rotation of the journal.

The application of the above laws will be clearer if the properties of two flat bearing surfaces are examined. In Figs. 14 and 15 the fixed surface may be looked upon as the partial bearing and the moving surface as a journal or collar.

Fig. 14 shows a wedge which decreases in thickness throughout the length of the fixed surface in the direction of motion of the moving surface. At the entering edge the pressure is *Pa*. The pressure increases above *Pa* in the direction of motion.

Obviously under the prescribed conditions this pressure cannot continue to increase until the far end of the fixed surface is reached because at that point the pressure must again be *Pa*.

There will, therefore be a maximum pressure somewhere along the film. Beyond that point the pressure must fall so as to adjust itself to the terminal condition of atmospheric pressure.

At no point, however, will there be a pressure below atmospheric. Hence, to this extent Fig. 14 follows the law above stated. The pressure curve is indicated by the light line above the moving surface. The velocity variation curves are indicated as in Fig. 13.

Referring now to Fig. 15, the fixed surface is so set with relation to the moving one that only a vacuum can be produced. The pressure will therefore start at the right at *Pa*—will fall to *Pmin*—and then rise again to *Pa* at the left end. At no point will there be a pressure above atmospheric. To this extent the law above stated is followed. The velocity variation curves are indicated in this figure also. Obviously the arrangement shown in Fig. 15 could only carry a negative load.

Combining the fixed surfaces of Fig. 14 and 15 we have the arrangements shown in Fig. 16. At the point, *A*, where the two wedges join, the pressure generated by the entering diminishing wedge would equal the pressure that enters the enlarging wedge.

This arrangement might be expected to produce atmospheric pressure at *A* and under certain designed proportions would follow the curve *B*.

Under other wedge proportions, indicated by the first dotted line above the fixed surface *A*, the pressures would follow curve *C* with only a small negative pressure. For still other proportions, indicated by the second dotted line above the fixed surface *A*, the pressures would follow the curve *D* and there would be no negative pressure whatever.

For the wedge proportions in Fig. 16, in which the pressures follow curve *B*, the bearing might be made with a groove at *A* as illustrated in Fig. 17. This groove is assumed to be open to the air so that the pressure in it would be *Pa*. This being the case, it is obvious that, whatever the proportions of the wedges might be the pressures at the right of the groove *G* would be always positive and those at the left always negative.

It is obvious also that if the proportions in Fig. 16 were so arranged that the pressure variation followed the curve *D* and we then cut an oil groove at *A* this pressure distribution *D* would immediately be upset and the curve would assume the character of the two curves in Fig. 17 and the carrying capacity of the bearing would be greatly diminished.

Carrying this idea still further, in Fig. 18 the same condition is shown as in Fig. 14 except that the fixed surface has a groove across it. With this groove in place the pressure will increase from *Pa* at the right end to *P' max* and then fall to *Pa* at the groove.

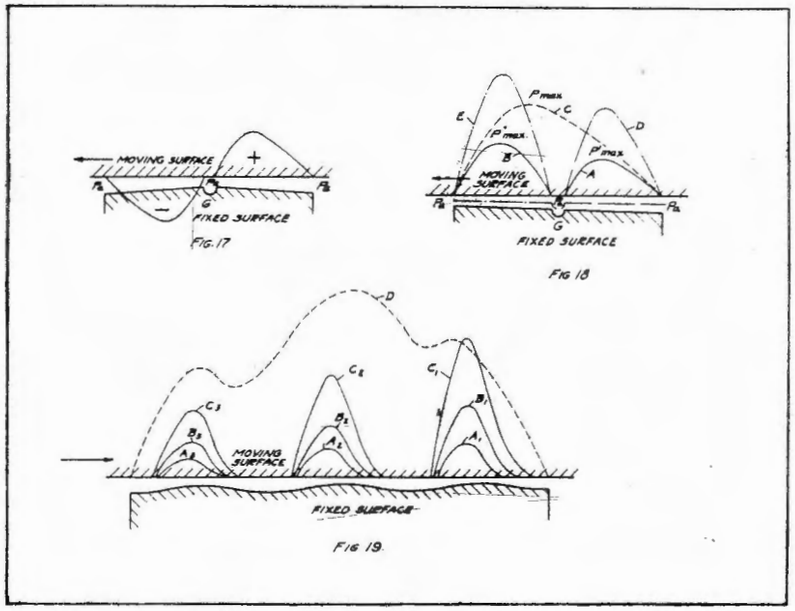
It will then increase to a greater *P''max* and then fall off again to *Pa* at the left end of the fixed surface. These pressure variations are illustrated by curves *A* and *B*. If the groove should then be removed the pressure would increase from *Pa* at the right end, along curve *C* to *Pmax* and then decrease again to *Pa* at the left end of the fixed surface.

Since the area under the pressure curve is proportional to the carrying capacity of the bearing film it is quite obvious that the film of Fig. 18 would have a much greater carrying capacity without the groove than it would have with the groove.

The thinner the oil wedge when compared with its length in the direction of motion, the greater will be its carrying capacity—that is, the higher will be the pressures generated within the film.

If the general proportions of the film in Fig. 18 are kept constant and the mean thickness is reduced by about one-half, and the groove still retained, the pressures generated would follow the curves D and E.

The combined areas under these two curves might be approximately equal to the area under curve C. This means that the fixed surface of Fig. 18 without the groove would carry a given load with a much greater film thickness than would be required to carry that load if the fixed surface is grooved. This same general law holds true whether the surfaces are curved or flat.



Hence, when a groove is cut across the loaded surface of a bearing and connected with the atmosphere the bearing will carry less load for a given film thickness than if the groove is omitted.

In Fig. 19 a flat moving surface is shown riding on a wavy fixed surface. The wave tops are assumed to be cylindrical with their elements perpendicular to the plan of the drawing. The tops of these waves represent approximately the same lubricating conditions as previously illustrated, or a ser es of bearings like Fig. 17 with the groove G omitted.

The depressions, if they are great enough will represent oil grooves connected with the atmosphere. When a bearing is made in this way the humps will have to carry the load. If these humps have small radii of curvature the pressures generated by them will follow pressure curves A_1, A_2 and A_3.

If the radii of curvature are increased the pressures would follow curves B_1, B_2 and B_3. If the radii of curvature are still further increased the pressures would follow curves C_1, C_2 and C_3. Each of these forms would have a definite carrying capacity. If now the thicknesses of the films are decreased these capacities would be increased, whereas with thicker films they would decrease.

Obviously also, if the general shape of the space between the fixed and moving surface is wedge-shaped in the proper direction and the depressions are not great enough to allow the oil pressure to fall to atmospheric, the pressure curve would then take on the character illustrated by curve D.

From the above discussion it should now be easy to picture to ourselves the influences of oil grooves and poor fitting upon the lubrication of bearing surfaces.

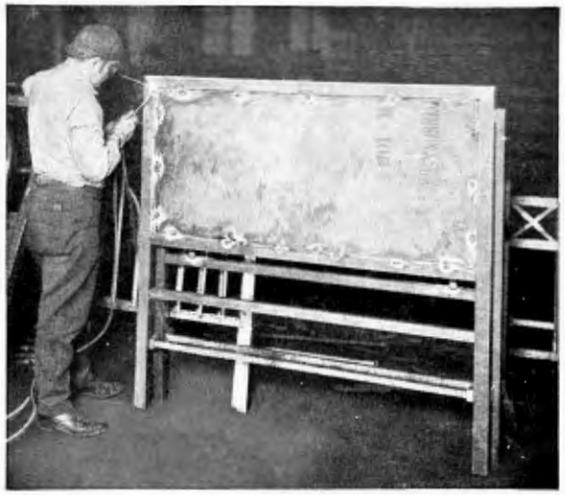
In the whole discussion above, it has been assumed that the bearings are supplied with enough oil to maintain the continuity of the films.

Discussion of friction and its relation to the rate of distortion in the lubricant at the bearing surfaces has been deferred in the interest of brevity.

A Resume of the Fields of Application Oxy-Acetylene Welding and Cutting

By D. S. Lloyd '25

In presenting a paper on the Oxy-Acetylene process to engineers, the writer is under the impression that the adoption of a conservative view of its merits and a candid expression of opinion as to its limitations will prove the most interesting. It is therefore the intention to describe only those applications of the process which have been very successful in reducing costs in the commercial field.



Spot welding metal furniture. This is one of the older applications of oxwelding to manufacturing and is therefore very highly developed.

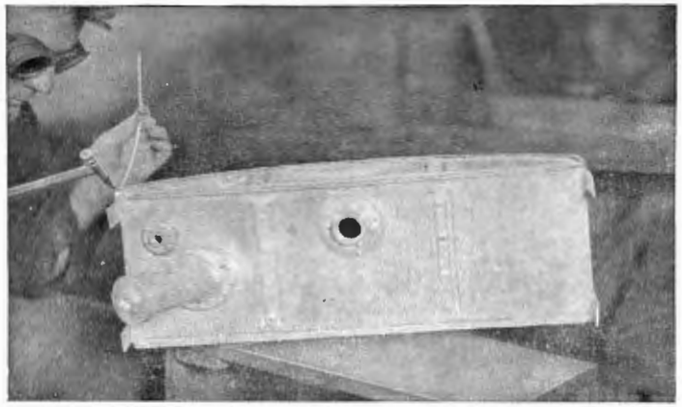
The Oxy-Acetylene flame was only a laboratory curiosity from the time of its discovery in 1895 until Oxygen was produced commercially in 1902. The use of the flame for joining and severing metals has therefore been developed since that time. The tremendous impetus received during the war in perfecting various phases of the process has made it very difficult for engineers to keep abreast of the newer developments, and it is almost impossible to state definitely that any degree of perfection described is the ultimate in that field at the present time.

The process is used in welding practically all metals and in cutting steel, wrought iron and cast iron. Its application can therefore be divided into four general classes—Production Work, Construction, Repair and Cutting. Since even a general description

of each of the thousands of uses would take several volumes, representative ones will be outlined in each class of work and other operations can be visualized from these.

Production

Under the classification of manufactured articles in the fabrication of which Oxy-Acetylene welding and cutting can be economically employed, come boilers, water, gas and oil storage tanks, barrels, metal furniture and fixtures, electrical equipment, refrigerating apparatus, kitchen utensils, automobile parts, steel ranges and laundry machinery made of steel or wrought iron; small optical and dental goods, ornamental ware, tubing, chemical stills, retorts and tanks, utensils, cannery equipment, automobile bodies and aeroplane parts are made by welding brass, copper, bronze, aluminum, monel metal and special alloys of various kinds.

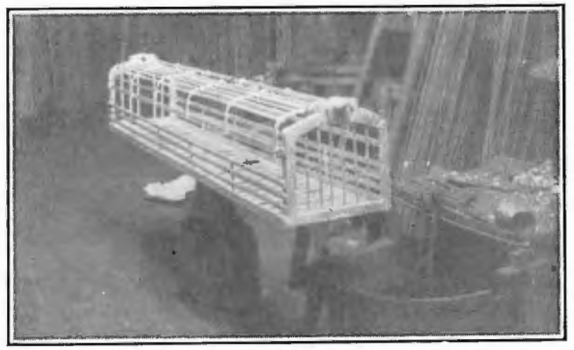


Special sheet metal tanks made with the blowpipe.

So very numerous are the ways of applying welding and cutting to the manufacture of metal products, that it is difficult to make an accurate statement of the advantages of using the process which will apply to the whole field. In general, and this applies to the majority of operations, it may be said that the cost of jointing is decreased, greater strength is obtained over any riveted design and the appearance of the finished article is improved. There are several factors which will decrease the cost, the most important of which is the greater simplicity of the design. Design and draughting costs for an all-welded article have proven to be less than half those where riveting was employed. The decreased weight of metal for a given strength and the increase in speed of fabrication by using welding are also responsible for decreases in the total cost in many instances. The smooth surface of a welded joint also cuts down the cost of finishing where painting or other

covering is used. This is a considerable factor when asbestos or other heat insulating covering must be employed.

Since this process is comparatively new and procedures are being changed every day to employ welding, a few words will not be amiss on the subject of factors which should be considered before making such changes. The design should first be considered. As pointed out above, the weight of metal can be cut down and finishing steps simplified, but only by a study of similar operations can full advantage be taken of the benefits of welding. The cost of equipment for any ordinary operation will range from fifty to two hundred and fifty dollars. The life of such equipment with usual wear and tear may be taken as ten years. The speed of operation is affected so much by the method of applying the pro-

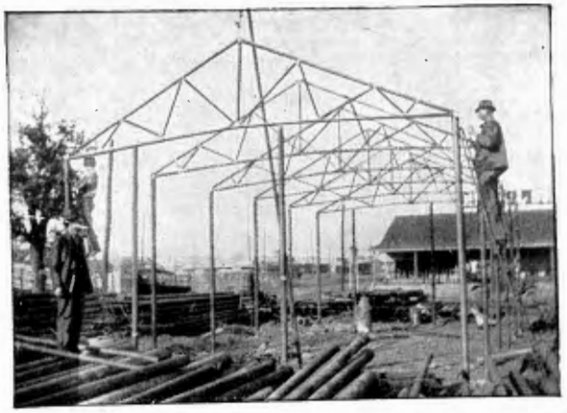


A pasturizer basket for a brewery, fabricated entirely by oxwelding. Note the absence of rivets or castings. The cost of the basket is less than that of the one previously used and it is 32 lbs. lighter. By the use of these, over 1½ tons of weight was taken from the working parts of the Pasturizer although the strength of each basket was increased.

cess, the ability of the operator and the choice of proper equipment that it is usually advisable to seek the assistance of the service engineers of the equipment and gas manufacturers, whose business it is to keep up to the minute on new methods of application and who spend their entire time developing new uses. They can show approved methods of testing operators, materials and finished welds, recommend and show the operation of proper equipment and suggest changes in design which have previously proven economical. By turning over to them the development work in connection with a new application, the cost is reduced enormously, as their laboratories are fitted for just that kind of work. Any reputable manufacturer in this business will be in a position to do this.

Construction

Entering the field of construction in the consideration of the uses of the Oxy-Acetylene flame, one finds considerable development going on at the present time. For years cutting has been employed to a considerable extent in fitting structural shapes on the job, but only in the last three or four years have any definite steps been taken to establish welding as an approved method of jointing structural steel. While buildings have been erected in which all the steel was welded, and although investigations are under way to establish a practical basis for the design of oxwelded joints for structural shapes, it will probably take considerable time for this information to be spread to all the engineers in the construction field.



Oxwelding the framework for a warehouse. A successful application incident to the investigation of welding all structural steel for buildings.

Oil, steam, air, gas and water pipe lines, storage tanks, oil and gas well casings are constructed by welding, which is now accepted as more economical, as well as more satisfactory, on this type of work. The greater strength of welded over riveted or threaded joints as well as the decreased time required for erection makes this method peculiarly adapted for construction work. Rail bonding for the electrification of steel tracks is successfully done in all parts of the continent with bronze or copper filler applied with the Oxy-Acetylene flame.

The field of jointing of pipe and fabrication of pipe fittings has reached such a stage of development that no paper on oxwelding and cutting would be complete without calling attention particularly to this work. Starting six or eight years ago in an endeavour to cut the cost of constructing and maintaining the miles of pipe lines in the oil fields, this process developed so rapidly and proved

its worth so clearly that it has been accepted as almost universally desirable wherever pipes are used. Steel pipe can be welded throughout and both standard and special fittings made on the job. Random lengths of plain end pipe afford the Purchasing Agent a field for economy at the outset, and when this has been placed on the job with the welders and their accoutrements, he has performed his part of the work. Approved Procedure Controls

Special Tee and Bend in 6″ steel pipe. Note the decreased friction factor in this pipe special.

have been prepared for pipe joints and all types of tees, elbows reducers and headers, both standard and special, can be fabricated on the job from short ends. It is generally accepted that fittings and joints in sizes larger than 2″ diameter can be made cheaper than by using screw or cast joints, but when welding is used throughout in an installation, the total cost can be reduced by welding every joint in even the small sizes of pipe.

Copper, brass, cast iron, wrought iron and steel piping for plumbing and heating systems in buildings is now being welded or bronzed, and such systems have proven not only more economical to install, but absolutely leak-proof and therefore less costly to maintain. Copper and alloy piping and utensils are extensively used in ocean going vessels and all joints and fittings are made by welding. Aluminum, copper, lead and special alloy piping and

Oxwelded return bend, reducer and end plugs. These are brass fittings—harder to make than steel ones but just as efficient.

A Tee in steel pipe made by cutting and oxwelding.

containers are used extensively in oil refineries and chemical plants, and oxwelding has entirely replaced any former method of making such special equipment.

It might be mentioned here that the old difficulty is encountered by engineers in getting a candid and unbiased opinion from workmen (and sometimes foremen) on the practicability of using this new process for the jointing of pipe. After all, it is the men in the shop who do the work and it is natural to have to turn to them for data on the actual application of a method. The individual members of some trade unions seem to take a delight in pointing out the defects of any new process which may temporarily curb their

effectiveness, and they have a tendency to exaggerate the problems encountered in new design. The best way for an engineer to find the facts about this process is to take data and information from heating and plumbing contractors who have used the process, rather than from those who have directed their energies towards the older methods. Results are what count and these can be better shown by the first class of experts than by the second.

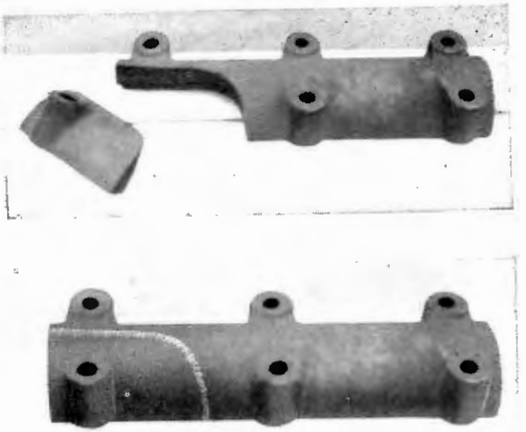
Among the special alloys for which welding procedures have been and are being developed are monel metal, duriron, alcumite and stellite. This latter alloy is increasing in usefulness as a means of obtaining a very hard wearing surface which is not affected by heat. It can be applied as a welding rod to the surface of steel or iron castings, forgings or rollings and presents a harder surface when running at dull red heat than when cold. The applying of this metal is done almost entirely by use of the Oxy-Acetylene flame, and correct procedures have been carefully worked out so an average welder can successfully apply it with a little practice.

Repair

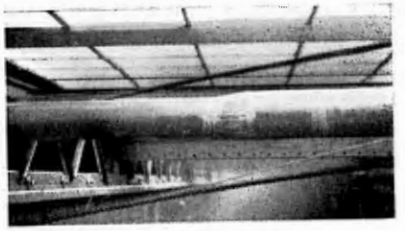
When oxwelding is mentioned to anyone not familiar with its wide fields of application, they immediately think of its use in connection with the repair of broken metal parts. Indeed, the use of the flame was first developed in the reclamation of unserviceable parts of machinery. This has naturally proved a boon to the industry, as plant men have gradually come to the point where they ask, "Can it be welded?" before thinking of sending it to the scrap heap.

Repairing the broken spokes in a large flywheel. Note the use of firebrick to localize the heat and increase the speed of the operation.

Although it would be impossible to list all the different parts which have been repaired by oxwelding, the following list will give an indication of the types of work in which it is employed:



A typical welding repair job, showing a small casting before and after.



A reducer coupling in this industrial plant was leaking. This is how the welder remedied the trouble.

Steel and Wrought Iron.

Boilers, tanks, piping, receivers, barrels, railway rolling stock and track (steam and electric), boat parts, automobiles and tools may be welded or bronzed when broken or worn.

Cast and Malleable Iron, Steel, Brass and Aluminum.

Light and heavy castings of all kinds; cracks, breaks blow holes, cold shuts, etc. may be repaired.

Sheet Brass, Copper, Monel Metal and Aluminum:

Automobile parts, kettles, tanks, retorts, special chemical equipment, utensils, pipes, headers and fittings may be put back in service.

Of course any of the operations prev ously described in manufacture and construction can be successfully applied in repair. The greatest factor to be taken into consideration in using the flame if a successful job is to be had, is the expansion and contraction

of the metal due to the heat applied. This is more noticeable in the repair of existing machinery, although of equal importance in all oxwelding procedures. If the work is carefully studied and procedures planned ahead, this property of metals may be made to work for, instead of against, the success of the operation, and satisfactory work can always be done. One of the most noticeable marks of the successful and competent workman is the care he uses to line up his work before starting and the allowances he makes for the movement of the metal during the operation.

Cutting

The fields of cutting by the Oxy-Acetylene process are closely related to those of welding although the actual process is entirely different. Whereas the welding flame acts on the metal to bring it to a temperature above the melting point, and the force caused

Cutting Cast Iron with the oxy-acetylene blowpipe. The ragged kerf is characteristic of this operation. A cut in steel is much smoother.

by the gasses passing from the tip is used to work the metal so a homogeneous weld is obtained, the flame of the cutting blowpipe is merely for preheating. The actual cutting is done by a jet of oxygen passing, usually, through the centre of a group of preheating jets, which combines with the iron of the material to be cut when it is near the melting temperature. This combination of oxygen and iron forms a slag of iron oxide which is blown from the line of cut by the force of the cutting stream.

Structural shapes, armor plate, boiler and tank manholes, billets, heavy connecting rods and such steel and wrought iron products are formed by cutting with Oxygen and a great reduction in cost is effected by its use. Standard sizes of rolled plate, shapes and bars can be transformed into intricate finished products by

cutting. Cast steel risers are removed from castings in foundries and steel mills, and the use of this process has simplified to a considerable degree the intricacies in design.

Oxygen cutting reduces the cost of demolition of bridges, boilers, steel buildings and other such structures and enables the material to be reduced to charging box size as it is dissembled. In

The oxygen lance, used in the cutting of skulls and spills as well as in ordinary cutting operations in metal more than 20″ in thickness.

the case of large iron castings, this method at times is the only practical one which permits the removal of large machinery from buildings without necessitating the removal of walls. Cutting cast iron is three to four times as expensive as the cutting of steel, but is finding a larger field of application each year because of the simplicity of the operation and comparative small cost of equipment.

In the fabrication of pipe specials and fittings, cutting is found to reduce the cost and simplify the operation to a great degree.

The portions to be welded may be bevelled in the same operation in many cases, thus reducing the cost of preparation for the final operation.

Many different fuel gases have been put forward as being cheaper for use with Oxygen in cutting steel, and are used to some extent. The general consensus of opinion at the present time seems to be, however, that gases such as Hydrogen, Carbo-Hydrogen and Pyrogen have a limited field of usefulness in the steel industries, and that Acetylene is as economical and much simpler to use in the majority of cases.

The Oxygen Lance is another form of applying Oxygen as a cutting agent for severing metals by oxidation. This is nothing but a steel pipe, the end of which is heated to red heat after which a stream of Oxygen is passed through. This causes the end of the pipe to oxidize or burn and a puddle of molten metal is formed on the article to be cut. The heat given off by the burning of the iron brings the adjacent metal to cutting temperature and allows the operation to be continued, in most cases without the application of additional heat. The flame of a welding blowpipe is sometimes used to supplement this exothermic action to increase the speed. Cuts up to 15 and 20 feet in thickness have been made with the lance permitting skulls and spills to be reclaimed for remelting and providing a simple method of removing frozen shafts, cutting deep holes and otherwise changing the nature of large rolled and cast steel parts.

Conclusion

In conclusion, the writer would like to point out that the more intricate of the operations described in this paper are only successfully carried out when the fundamental rules of welding are adhered to strictly. Good welding cannot be done consistently by a novice and men should therefore be properly trained; good equipment should be provided and supervision of the upkeep of this apparatus vested in a responsible individual. While welding rods and flux are the least expensive factors in a weld, they are of the utmost importance. The best obtainable should be used regardless of cost. Above all, safety rules should be rigidly enforced not only for the benefit of the workmen, but for the ultimate and consistent success of the application. If these factors are properly considered, the welding of steel, cast, malleable and wrought iron, bronze, brass, sheet and cast aluminum, lead, copper, monel metal, stellite and many other alloys, resolve down to automatic operations which net industry millions of dollars per year. Putting this amount within the realm of thought of most engineers, hundreds of dollars can be saved in any industrial plant in this country if a little thought is put on the proper application of the Oxy-Acetylene process.

Methods of Improving the Efficiencies and Powers of Motor Car Engines

By G. L. DeLaplante '27

Within the last twenty years perhaps nothing has been developed and come into general use so rapidly as the motor car. From a thoroughly unreliable and imperfect mechanical toy, it quickly reached the stage where reasonable reliability could be placed on its performance and it passed from a vehicle, at first regarded as a novelty and luxury only, to one of dependable transportation. The motor car as it is built now usually has ample power, but its efficiency is low and it is, therefore, not economical. Also, development is taking place more in the way of refinement or perfection of detail rather than in the improvement of fundamental principles. Since our fuel supplies are being exhausted rapidly on account of the very large demand, and cars are becoming a means of transportation to the poorer classes as well as the wealthy, designers should endeavor to build engines that will produce the required amount of power from the minimum amount of fuel, which means engines of high efficiency. To many who have not studied the question, automobile racing seems senseless and an unnecessary hazard, but had it not been for the experience gained through racing, the passenger car would not have attained its present state of perfection as quickly as it did. Following the history of racing, it is evident that the design of passenger car engines has followed not many steps behind that of racing car engines and if further improvement is desired, it would be well to investigate the trend of the latter today. The most notable feature in connection with racing engine design at present is the development of large powers from very small engines. In the last Indianapolis Classic, the piston displacement was restricted to 90.2 cu. in., a little more than half the size of the Ford engine. Some of these pigmy engines develop as high as 150 brake horsepower. These extraordinary results were obtained by high speed and supercharging. The various factors that influence the power and efficiencies of the internal combustion engine working on the Otto cycle will now be considered.

The indicated horsepower of a fourstroke internal combustion engine is,

$IHP = \frac{pLAn}{33000 \times 2}$ for each single-acting piston, where

p = the mean effective pressure in *pds.* per sq. in.
L = the stroke in ft.
A = area of piston in sq. in.
n = the revolutions per minute.

Therefore, for an engine of given dimensions and speed, the indicated horsepower depends upon the mean effective pressure. The indicated mean effective pressure consists of the fuel-energy-

content multiplied by several efficiencies, $I.M.E.P. = Ae \times Ce \times Ve \times (D \times 12)$ where

Ae = Air-cycle efficiency,
Ce = Relative efficiency, on Air-cycle efficiency,
Ve = Volumetric efficiency,
D = Foot-pounds of energy per cu. in. of mixture.

Since the fuels that are used at present are fairly uniform in composition, the last term in this equation may be considered constant. Hence, in order to obtain a high mean effective pressure, the efficiencies by which this term is multiplied must be as high as possible. The efficiency of the Otto cycle is $1-\left(\frac{1}{r}\right)^{n-1}$ and if air only is used, it is called the air standard or air-cycle efficiency. For air n is 1.4 and this efficiency becomes $1-\left(\frac{1}{r}\right)^{.4}$. It is impossible to obtain this efficiency in practice because the actual working fluid varies from the ideal air assumed in the equation. Various deviations from the true cycle, losses due to changing specific heat of the working fluid, dissociation of the products of combustion and losses by radiated heat to the walls of the combustion chamber, cause a further loss.[1] From the equation $1-\left(\frac{1}{r}\right)^{.4}$ it is evident that the efficiency is dependent on the compression ratio, r, the higher this ratio, the higher the efficiency. Owing to the differences between the ideal and actual cycles, and the losses mentioned above, the observed thermal efficiency differs from the air cycle efficiency by the amount shown in Fig. 1, the efficiencies being plotted against the compression ratio.

The relative efficiency Ce is the ratio of the indicated thermal efficiency to the air-cycle efficiency. The volumetric efficiency Ve is the ratio of the volume of charge drawn into the cylinder during the suction stroke to the volume swept by the piston in one stroke. This efficiency is influenced by many factors and will be discussed later in connection with super charging. If the speed is constant, and the air-cycle and volumetric efficiencies are kept constant, it is evident that the relative efficiency is a measure of the combustible efficiency. Of all the features of design which control both the power output and the efficiency of an internal combustion engine, by far the most important is the form of the combustion chamber.[2] Upon this depends not only the combustion efficiency, but also, to a very large extent, the liability to detonation; and detonation by limiting the compression ratio sets an additional limit on the efficiency. Therefore, in order to employ a high compression ratio, the causes of detonation and its prevention will now be discussed.

Many theories as to the cause of detonation have been put forth, but recently Mr. Tizard's theory has received most support. The phenomenon of detonation, in short, is that after the compressed charge has been fired by the plug, the whole mass ignites

spontaneously and results in a ringing knock or what the engineers call "ping". This occurs when the rapidity of combustion of that portion of the charge first ignited exceeds a certain rate and the increase in temperature due to the adiabatic compression of the remaining unburned charge raises it above its auto-ignition temperature. This explosive wave strikes the cylinder wall and causes the peculiar metallic sound. Detonation is not influenced

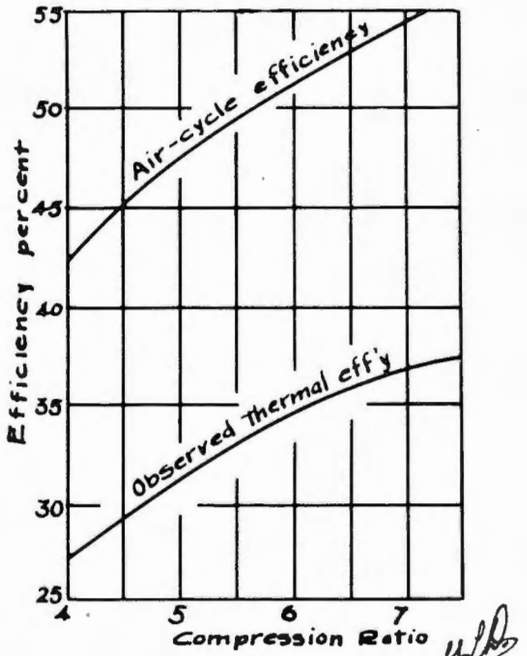


Fig 1.

by the temperature or pressure of compression as was once thought but by the rate of burning of that portion of the charge first ignited and by the maximum flame temperature. The amount of exhaust products mixed with the fresh charge has a marked effect upon detonation, the greater the percentage, the less the tendency to detonate. This explains the reason that increasing the compression ratio increases the tendency to detonate; for the dilution of the fresh charge by exhaust gases is decreased owing to the reduced clearance space, and the flame temperature rises. Also throttling eliminates detonation, as the ratio of exhaust products to fresh charge is increased and the flame temperature falls.[3] The density of the fuel in the mixture also has an influence on detonation. Lean mixtures will not cause an engine to "knock"

nearly as quickly as richer mixtures unless the mixture becomes over-rich when the surplus fuel acts like a diluent as in the case of the exhaust gases. The tendency to detonate depends greatly on the kind of fuel used. In general, the simpler and lighter the molecules are that compose the fuel, the more stable is the fuel and the less will be the trouble from detonation. So, if alcohol, one of the most stable of fuels, is used in an engine, a compression ratio of 14 to 1 may be employed without detonation. The fuels that are on the market today necessitate compression ratios of around 4 to 1. Since gasoline is our standard fuel, the possibility of other fuels will not be considered in this thesis.

It is evident, therefore, that to use desirable high compression ratios, detonation must be controlled. For some time it has been known that the addition of cool exhaust gases or other diluent, prevents detonation. The explanation offered is that the inert gases lower the rate of reaction of the combining gases and this in turn reduces the flame temperature. Although this practice has been applied to large gas engines, no data are available with regard to its application in the case of the motor car engine, so this will not be considered. Design of the combustion chamber and such parts as spark plugs, pistons and rings has a great influence on the control of detonation. Since the combustion chamber has such an important bearing on the combustion efficiency also, it will be discussed here.

In the design of the combustion chamber, the most important considerations are:

(1) The maintenance of turbulence;
(2) The position of the spark plug;
(3) The avoidance of any pockets where the gases may become stagnant;
(4) The provision of a free and unobstructed entry for the gases after passing through the inlet valve.[4]

In order to understand the importance of turbulence in connection with flame propagation, efficiency of combustion and high speed, it will be necessary to make a short study of flame velocities. Fig. 2 shows the four phases of flame velocity that take place in a long tube closed at one end and containing a quiescent mixture. From 1 to *A* acceleration occurs and is called the first acceleration. The condition is similar to that found in a typical combustion head with lean mixtures at light loads and is characterized by a smooth, sweet-running engine.[5] *A* to *B* is known as the first uniform velocity and in an engine represents nearly full-load performance with lean mixtures in low-compression engines, the operation being without roughness. *B* to *C* is known as the second acceleration and represents conditions in an engine having too high a compression-ratio for available fuels and running at full throttle, either accelerating or at full load and particularly at slow speed. The engine action under these conditions is rough. *C* to *D* is the second uniform velocity known as detonation. Such a reaction is brought about by an engine having too high a compression-ratio for available fuels, the engine operating at full load with a perfect mixture. In this case the engine performance is very rough. Particularly in high speed work, it is essential to consume the largest volume of mixture in the shortest possible time. It is evident from the above that the flame velocities must be kept below the point *B* and therfore increased volume consumption cannot be accomplished by high flame velocities. The alternative method is to provide a combustion chamber shape that will allow the flame crest to spread out so as to present an ever increasing area of contact with the unburned mixture. This shape is clearly a sphere with the ignition point in the centre. Many points of ignition allow a great volume of mixture to be

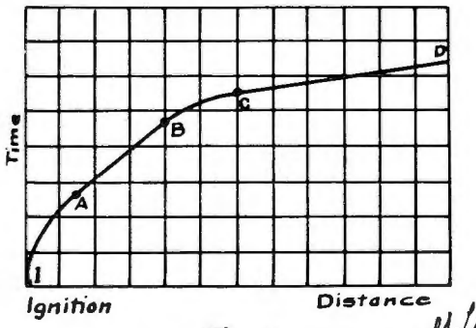


Fig 2.

consumed without danger of high unit velocities of the flame at any part of the mixture. If sufficiently rapid circulation of the gases is produced, that is, sufficient turbulence, it is possible by igniting the gases at the point of greatest rapidity of movement to approach approximately the effect of a multitude of "ignition points". These "ignition points" so distributed throughout the mixture initiate numerous spheres of flame, and therefore, an infinite number of small velocities and rapidly increasing flame areas. Thus a maximum volume of mixture is consumed in a given time without approaching the flame velocities of detonation.[6] Turbulence aids further in providing the consumption of a larger volume of gas in a given time by driving the layer of cool gas adjacent to the combustion chamber walls into the flame and replacing it by the products of combustion. For practical reasons, it is clear that a combustion head cannot be made in the shape of a sphere with the ignition point in the centre. Valve-in-head and sleeve-valve engines are the nearest approach to this ideal, and where side pockets are used, turbulence is of greater importance since the ratio of surface to volume is greater in this type than in the former two. The ignition point cannot be placed in the centre, but its position is of great importance. The three parts of a com-

bustion chamber that have a higher temperature than the average are the spark plug, the exhaust valve and the centre of the piston. The temperature of the gases in the vicinity of these parts is raised and the advancing flame crest on reaching them would tend to set them off by auto-ignition. Therefore it is advisable to place the ignition point near these hot surfaces allowing the hot gases to be fired first rather than to have them fired near the end of combustion when temperatures and pressures are high. Turbulence plays a part in this connection also, as the gases are in rapid motion past these hot parts in the combustion chamber with the effect of maintaining a more uniform temperature of the gases and preventing local hot masses of mixture.

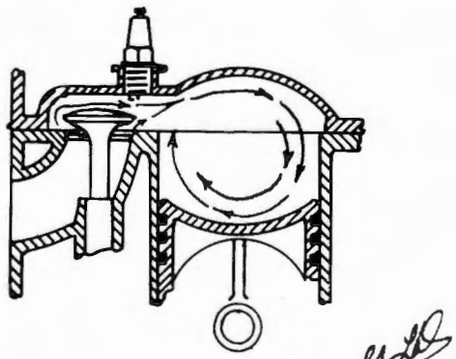


Fig. 3.

There are two methods of producing turbulence that have been adopted, and in each, the shape of the combustion chamber is of great importance. The one used more commonly is by means of the intake-gas velocities, the higher the velocity through the intake port, the greater being the resulting turbulence. This velocity is retricted on account of volumetric efficiency as will be shown later. A serious disadvantage of this method is the fact that the velocity of the gases is greatly cut down on leaving the small intake port and entering the large cylinder. There is also a dampening influence to the velocity during the compression stroke. In producing turbulence by this method, the main point to be observed is to provide a combustion chamber shape that offers no obstructions or resistance to the main flow of the gases. Fig. 3 is a type of head designed by Ricardo in which this principle is employed. It conforms to the above requirements and is reported to have given excellent results. The arrows indicate the flow of the gases. The second method of producing turbulence is by means of piston compressions and is being adopted more widely in recent years. It consists of forcing the charge through an orifice during the compression stroke. The pocket serves as the com-

bustion chamber. Its advantages are at once apparent, as the gases are at their maximum velocity at the point of ignition, at which point only the turbulence is of any value, because the path of the flame is determined by the turbulence at the point of ignition. Fig. 4 shows a head designed by Ricardo employing this principle, and Fig. 5 shows the arrangement of the same head in plan. It is evident that the velocity of the gases through the inlet valve and oriifice need not be as great as in the first method as the turbulence has not an opportunity to die down before ignition.

This means a higher volumetric efficiency as is indicated in Fig. 6 where volumetric efficiency is plotted against intake-gas velocity. This type gives a high mean effective pressure and good

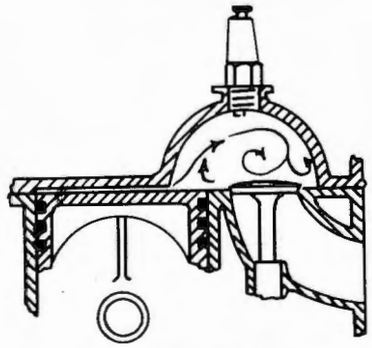


Fig. 4.

thermal efficiency at all speeds and with very little regulation of spark. It also has the desirable features of side valves, a compact deep combustion chamber, central location of the spark plug and the extreme distance which the flame has to travel is reduced to a minimum. It has proven equal to the overhead type both in power output and efficiency. Thus, turbulence is a great asset in the control of detonation and allows the use of higher compression ratios, producing correspondingly higher efficiency. The constant-volume cycle is based on the assumption that the working fluid receives all its heat at constant-volume and instantaneously. Although this is impossible for practical reasons, yet turbulence permits a much closer approximation to the ideal by speeding up the combustion and by driving off the surface layers from the combustion chamber and burning them before the expansion stroke commences. Ricardo states that detonation is also dependent on the distance from the spark plug to the farthest point in the combustion chamber and upon the time available to burn the charge.[7] The shorter the distance and the less the time, the higher will be the compression pressure that may be

utilized. This points to small cylinders and high speed. Turbulence permits high speeds by speeding up the flame propagation.

Recently, doped fuels have appeared on the market which are claimed to be immune from detonation. However, turbulence is indispensable to efficient combustion with dopes or without them. It is possible to wipe out entirely the advantages of increased compression allowable with dopes by low turbulence effects.[8]

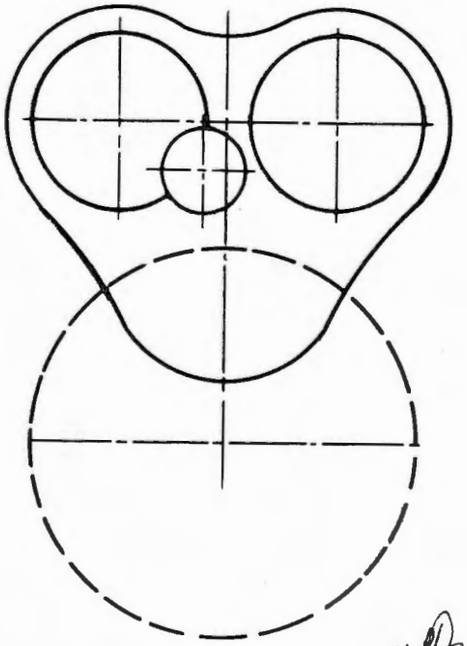


Fig. 5

It has been shown how great an influence the shape of the combustion chamber has on the power and efficiency of the engine, but there are other parts which if correctly designed will permit the use of higher compression ratios without danger from detonation. In experiments carried on by G. A. Young and J. H. Halloway, it was found that the spark plugs were the first cause of detonation.[9] They were able to study detonation from other causes by using specially designed plugs. Compression pressures as high as 125 pds. per sq. in. were employed without detonation by using aluminum alloy pistons with thick heads, well ribbed, and fitted with four piston rings. Engines of the poppet-valve type, using present low-grade fuels with properly cooled combustion chambers, spark plugs and valves, could be

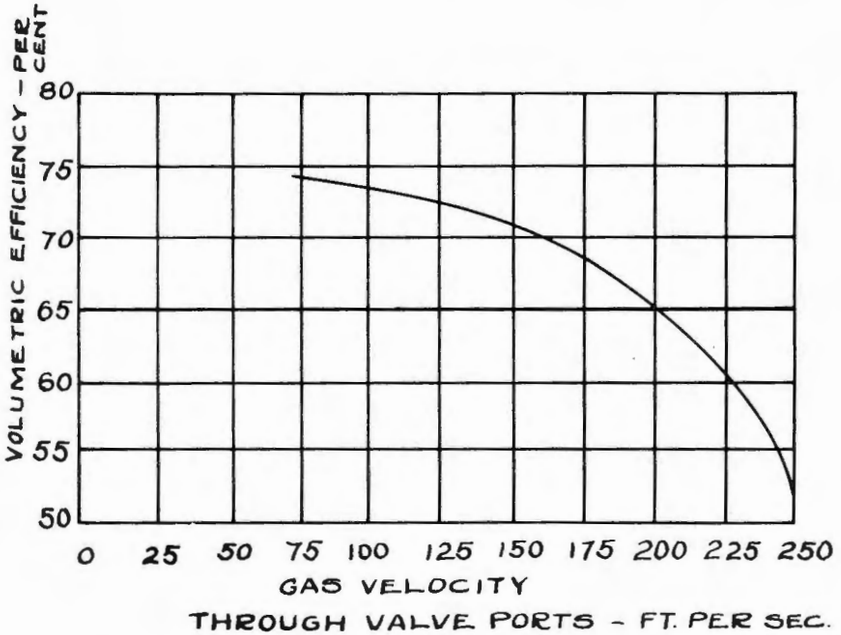
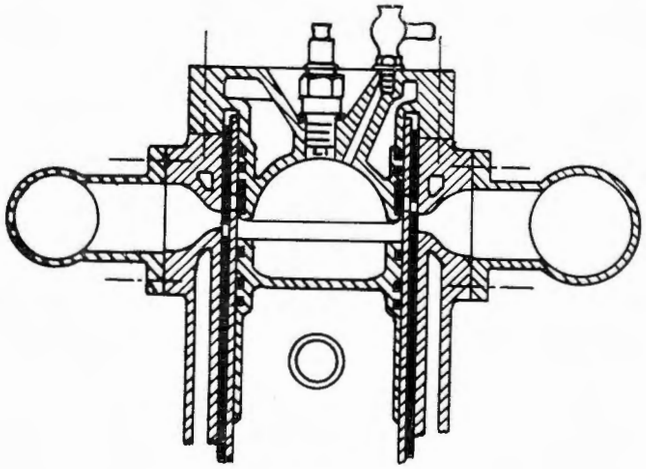


Fig. 6.

run at compression pressures not exceeding 110 pds. per sq. in. By preventing hot spots, and delivering cool mixture to sleeve-valve combustion chambers, a compression pressure of 125 pds. per sq. in. could be used in this type of engine. As the compression pressures used in present engine design seldom exceed 80 pds. per sq. in., it is evident that higher thermal efficiency can be obtained by careful design.

Another feature that affects both detonation and volumetric efficiency is the question of hot-spots. The external hot-spot used by many engine designers consists of some form of connection between the exhaust and intake manifolds so that the charge is heated before entering the cylinder and the purpose is to aid vaporisation of the particles of liquid fuel. However, experiments have proved that, as between a hot-spot system with a cool combustion chamber, and a cool intake mixture with a uniformly hot combustion chamber, the latter is preferable, both from the vaporisation standpoint and from the standpoint of power.[10] This is due to the cool intake mixture having a greater density, and therefore a greater weight of charge is drawn in. It has been stated that the spark plug, exhaust valve and piston have a higher temperature than other parts of the combustion chamber. These

are the internal hot-spots and should be kept at as low a temperatrue as possible. Where no external hot-spot is used, the piston is a valuable asset in aiding vaporisation because of its area and temperature. It is clear however, that its temperature must be kept relatively low since the liquid particles would assume the spheroidal state on pistons at the usual temperatures encountered. These are the conditions under which the sleeve-valve engine experimented on by Young and Halloway operated where a compression pressure of 125 pds. per sq. in. was used. In this type of engine the hot-spots are reduced to a minimum. Fig. 7 shows a cross-section of the head of a sleeve-valve engine.



SECTION OF
SLEEVE-VALVE ENGINE
Fig. 7.

The exhaust valves do not suffer from the high temperatures during the expansion stroke as in the poppet-valve type since during this period the valve ports are protected between two water-cooled surfaces. This removes the danger of one of the hot-spots. There are a number of spark plugs available that cool very well, removing the danger of another hot-spot. Pistons designed as stated in the pervious paragraph dissipate sufficient heat to keep the piston at a temperature beneficial to good vaporisation. The diagram indicates further advantages of this form of construction. The conditions outlined by Ricardo for the best form of combustion chamber are approached most closely. It is practically spherical in shape, the cylinder head being dome-shaped and the piston top dished. This shape is

excellent from a turbulence standpoint and the position of the spark plug in the centre is the best possible practically. There are no pockets and the entry of the gases to the cylinder is unobstructed both while passing through the inlet valve and after entering the cylinder, resulting in high volumetric efficiency. The sleeve-valve construction lends itself admirably to small size and high speed both of which allow a higher compression ratio than larger slow-speed types. The action of the sleeve-valves is quiet and positive regardless of speed while the hammering action of poppet-valves at high speed is not only noisy but destructive to the mechanism. The size of the valves in a poppet-valve engine must be reduced with the cylinder size, but the restriction in valve area is not affected to the same extent in a sleeve-valve engine as the valve ports are cut out of the sleeves. Although the thermal and volumetric efficiencies of the sleeve-valve engine are much superior to those of the other type, there are certain objections that have been raised against its adoption. Chief of these are:

(1) The mechanical efficiency is low due to the friction losses in the sleeves.

(2) The piston is hard to cool on account of the difficulty in transferring heat through the respective oil films and sleeves. These disadvantages are serious in the type where two sleeves are used as in Fig. 7, the sleeves being given a pure reciprocating motion by two short connecting rods operated by an eccentric shaft, but recently designs have appeared where one sleeve only is used with not only a reciprocating motion but a rotary motion as well. This construction divides both disadvantages of sleeve-valves in half and makes this construction preferable. Besides the three hot-spots mentioned above, there is another cause of hot-spots which in aggravated cases will cause detonation. This condition is produced by difficulties in cooling water circulation. In case there is obstruction to the flow of water upwards, the water near the hot surface of the cylinder or combustion chamber is heated rapidly and removed by a belch of steam. When the water returns, the surface is so hot that the water bounces off with little cooling effect. Thus a hot-spot develops and spreads and is liable to cause detonation. Besides the one mentioned, there are other and more serious defects in the conventional method of cooling the cylinder by water. The cylinder is overcooled to provide ample cooling capacity to take care of the most severe conditions of service, and it is necessary to maintain the water temperature sufficiently below 212°F. to preclude any possibility of boiling. Both of these conditions contribute to the lowered efficiency of engine operation. Since about 40% of the total heat derived from the fuel is lost to the cooling water, it is desirable to reduce this loss to a minimum. This cooling water loss must be large in any case in order to keep the temperature of the metal in the cylinders, pistons, etc., within workable limits. From many experiments made in Europe and in the United States, it has been

conclusively proved that excessive cooling by the water-jacket results in a marked loss of efficiency.[11] Dugald Clark, in England, a high authority in practical work with the gas-engine, found that 10% of the gas for a stated amount of power was saved by using water at a temperature in which the ejected water from the cylinder jacket was near the boiling point, and ventures the opinion that a still high temperature for the circulating water may be used as a source of economy.[12] The best operating temperature depends upon physical characteristics of metals, oils and gases. Tests to determine the effect of varying the jacket temperature on maximum brake horse-power, full and part-load economy and crankcase oil dilution indicate that a temperature of 212°F. or slightly over is desirable.[13] Obviously a water-cooling system cannot fulfil this requirement so steam-cooling or evaporative-cooling is the solution. To make a complete study of evaporative-cooling is beyond the scope of this paper, but its most salient features and advantages will be cited. In an evaporative-cooling system the water boils and a great deal more heat is abstracted from the cylinder by a given amount of water as the latent heat of the water must be supplied. Therefore, much less water need be used with this system, and, as the system is closed, the water need not be replenished. In its effect on the power and efficiency of the engine, maintaining a fixed cylinder temperature of 212°F. reduces piston friction. The National Physical Laboratory, England, found that increasing the cylinder wall temperature from 122° to 212°F. decreased piston friction from 50 to 70 per cent. and as piston friction constitutes from 50 to 60 per cent. of the engine friction, it is evident that evaporative-cooling increases the mechanical efficiency considerably. The danger from hot-spots is reduced to a minimum, as in the steam system of cooling there appears to be a more uniform temperature of all parts; the maximum temperatures are lower and the average is higher and more uniform. This is exactly what is favorable for high compression.[14] Also, the higher uniform temperature of all parts favors cylinder vaporisation, permitting cool intake gas temperatures, and resulting in higher volumetric efficiency which means more power for an engine of given dimensions. The effect of volumetric efficiency on the power of the engine will now be considered, and the advantages of using small, high-speed supercharged engines pointed out.

The power capacity of a cylinder depends on the weight of air which can be dealt with per minute. The fuel need not be considered since it can be made to combine with any given quantity of air by means of the carburetor. The prime factor upon which the amount of air handled depends is the volumetric efficiency, since the mean pressure and hence the power of an engine is almost entirely dependent upon it for equal temperatures and piston speeds. There are several things upon which the volumetric efficiency depends and these include the size and position of valves, the shape of the valve passages, the design of the pipe-

work, the compression ratio, the gas velocity and the suction temperature. The valves and passages should be designed to offer the least resistance to the flow of the gases. Obviously the constructions in order of their value in this respect are the sleeve-valve, valve-in head and heads with side-pockets. Fig. 8 shows the effect of the compression ratio on the volumetric efficiency. The loss in volumetric efficiency by raising the compression ratio would not be considered in comparison to the gain in thermal efficiency by so doing. Referring back to Fig. 6, the curve shows the variation of volumetric efficiency with change of gas velocity through the intake ports and was the average of a number of

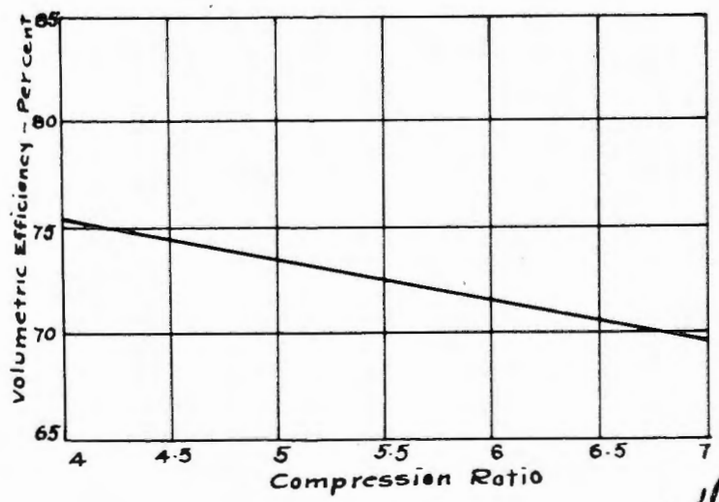


Fig. 8

different engines using poppet-valves. The velocity required to produce sufficient turbulence using intake-gas velocities is around 130 ft. per sec. It will be seen that the volumetric efficiency corresponding to this velocity is around 73%. With the best design of manifolds to reduce friction losses and with large free passages through the valves, timed so as to obtain all the advantages of the inertia of the gases, it would be impossible to obtain 100% volumetric efficiency by means of suction. This is the purpose of super charging; for super charging is nothing more than filling the cylinder with a greater weight of charge than would normally occur by means of suction, or in other words, increasing the volumetric efficiency above 100%. If the thermal efficiency remains constant, adding 50% more charge to the cylinder and consuming it increases the power derived from the cylinder by 50%.[17] As the fuel in an internal combustion engine is burned

within the cylinder, there is no reserve from which to draw in case there is a sudden demand for increased power, such as in starting or for hill-climbing. The power of such an engine varies with the speed up to a certain r.p.m. known as the peak. This peak varies with different engines. In order to provide sufficient power at low speeds, it has been the practice for designers and car manufacturers to use over-size engines in their cars, which under

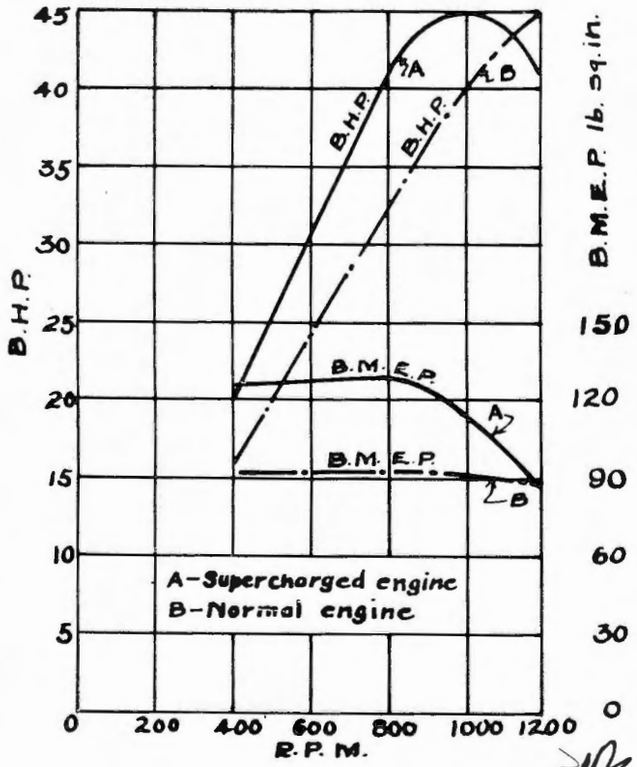


Fig. 9

ordinary driving conditions are operated at about half-throttle. Throttling curves indicate that fuel economies are realized at open throttles.[18] Therefore it would be advantageous economically to operate a small motor near its peak under ordinary conditions and when high torque at low speeds is required to bring a supercharger into action. Fig. 9 illustrates the advantages of the supercharged engine, its curves being shown in full while the curves of a normal engine of equal power are shown in dot and dash. The supercharging engine develops its maximum power not only at a lower speed but over a greater speed range. At speeds above the

maximum power, the r.p.m. is obtained at the expense of B.M.E.P. Therefore where high speeds are required, a higher gear than direct drive could be employed, and the engine operated without supercharge. By this method, cars could be made more powerful, flexible and economical and all with much smaller engines.[19] Space does not permit a description of the methods of supercharging, suffice it to say that some form of centrifugal pump or turbo-blower is used to produce the pressure required to supercharge the cylinder.

Another factor that increases the power of an engine is the use of as high a piston speed as possible, consistent with good mechanical efficiency.[20] The piston speed may be increased by using a long stroke or a high rotative speed. As the friction of an engine, which governs the mechanical efficiency, varies directly as the piston speed and as the square of the rotative speed, it is better to employ a long stroke and not such a high rotative speed.

If the design of motor car engines followed the principles outlined above, the engine would resemble the present racing car engine much more than the present motor car engine. It would be small, compact, powerful, flexible, highly efficient and would probably use the single sleeve-valve construction to ensure the desired quietness. Outstanding features would be supercharging, high speed and steam cooling. Thus, much can yet be done to improve the power and efficiencies of the motor car engine.

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ENGINEERING SOCIETY STORE.

THE YEAR BOOK

of the

University of Toronto Engineering Society

Faculty of Applied Science

1927

Our Semi-Centennial

The School is now Fifty Years Old

C. H. C. Wright, '88

Early next session (October 6, 7, 8 and 9) the University of Toronto will celebrate the Centenary of the granting of their charter and at the same time the Faculty of Applied Science and Engineering will celebrate their Semi-Centennial.

The graduates of the School of Practical Science will gather at the School in very large numbers, from coast to coast, and literally from the uttermost parts of the earth, to fraternize and join with the undergraduates in shouting "Toike Oike." The graduates of the earlier years were without any college yell; but the younger generations have since taught them theirs. At the coming celebration the graduates will, among other interesting ceremonies, present a splendid bust of John Galbraith, the first professor of Engineering, later Principal of the School of Practical Science, and afterwards Dean of the Faculty of Applied Science and Engineering. In order that the undergraduates may more fully appreciate the spirit underlying this presentation, a brief statement of a few of the earlier difficulties of the School may not be out of place.

During the late 50's and early 60's the citizens of Canada and the United States were demanding technical education in no uncertain terms. The mechanics, as well as those interested in the solution of the many intricate engineering problems of a new and growing country, through the medium of the Press and by influence in the Legislature, were demanding opportunities for education that they might execute their work more intelligently and design with greater efficiency and economy. Out of the first eventually grew our Technical Schools, while the second developed into the Faculty of Applied Science and Engineering.

When the Legislature could no longer resist the pressure, they established the Institute of Technology with accommodation in the Mechanics' Institute at Lombard and Church Streets. This first venture proved a failure, because the staff appointed had no appreciation of, nor sympathy for, such a form of education.

This did not satisfy those really interested, and the demand became even more insistent. They saw visions of Strength of Materials laboratories, Mechanical, Hydraulic and Thermodynamical laboratories and shops such as the new institutions across the line had.

Once again the Government of the Province made provision for this work and erected a new building for the purpose. Once again

the same mistake was made, and the curriculum for the first session looks like sections of the work from all the departments of pure science with a few lectures (to be delivered by a Professor of Engineering not yet appointed) injected by those who evidently did not appreciate the work. Thanks, however, to some mysterious outside influence and the courage and determination of the applicant, a professor was appointed before the first session who had entirely different views.

Professor Galbraith found, however, on entering the new S.P.S. building, that there was almost no room left for the work for which it was especially erected. The departments of Chemistry, Botany, Biology, Mineralogy and Geology had taken possession, and "Johnnie" was left with a room in which to hang up his hat, a lecture room which he was forced to share with others and a small drafting room. Due to his personality, determination and force of character, he was enabled under these trying circumstances to scrap the curriculum as advertised, form a new policy and carry it through. He alone believed in the future of the S.P.S. with a policy which his keen foresight had created. For years he struggled along without room or equipment, with a board that was, to say the least, very unsympathetic. For nearly ten years the only encouragement he had was the love of his students and graduates. Finally he persuaded the Honourable the Minister of Education to visit some of the institutes of Technology across the U.S. border, with the result that on his return the Government proceeded to provide for an addition to the S.P.S. building (finished in 1890), to add to the staff, to create a Council, and to promote Professor Galbraith to be Principal. In '88 the writer felt proud of his graduation, but has long prized even more deeply Johnnie's parting words, which were something like this: "If you believe in the future of the School and are willing to make the sacrifice, I would like to have you assist me in the making of an institution that some day, I believe, will be recognized not only by the University but by the country at large."

Fifty years ago we had our start, and what changes have taken place in the Engineering world! what changes in Canada, in Ontario! To enumerate these would be beyond the possibilities of this short article. Suffice it to say that whenever an exploration was required or a development of resources needed, there were always found in Johnnie's brigade of graduates, trained sons of Canada capable of efficiently and economically carrying out the commission. To-day the graduates include in their roster the names of many who are outstanding leaders in our and other communities in their chosen field of engineering and research.

The undergraduates in attendance next autumn will be particularly fortunate in the personal contact that they will have with so many of these distinguished graduates. I may be permitted to suggest that no undergraduate can afford to miss nor even half-

heartedly enter into the coming celebration, which will include a Special Convocation for the granting of honorary degrees, Inter-Faculty track meet, Intercollegiate Rugby, luncheons, banquetings, at-homes, receptions, special addresses or lectures, parade, etc.

A special committee of the Engineering Society has been entrusted with the responsibility of making the necessary provisions for the School undergraduate functions, and I feel sure that as in the past, the undergraduates will one and all stand loyally behind this committee in all its efforts, so that School's banquet, School's At-Home and School's part of the general parade will long be remembered by all.

School Sayings and Toike Topics

Positively *not* an Editorial

It is sad but interesting to observe the evolution of the supply department of the Engineering Society. Not so very long ago the store—better known in the student's vernacular as "The Engineering Society," since it was the most visible and concrete embodiment of an otherwise rather abstract institution—was the gathering place of all years and of all departments. Here almost all needs of the body and mind could be satisfied. Chocolate bars and apples were sold and bought (much to the financial benefit of the Society); smokes were provided for those who had the price—and they were many. And thus, to the friendly sounds of munching jaws and the pleasant squashing noise of apple-cores, thrown by able juniors at freshmen's necks, the questions of the day were settled by able minds and minds less able; athletic teams were arranged; last night's hockey games were played all over again—and the school men *got to know each other*. The "Eng. Soc." was the "general store" of that great village S.P.S. It was the corner bar, the Pullman smoker, the parliament lobby and the workshop lunch corner all rolled into one. No type of School man worthy of the name could or would afford to stay away for even a single day. He would be a despisable ignoramus. In the "Eng. Soc." was carefully hatched, brewed and distilled that subtle, undefinable "je ne sais quoi," cherished by those who are old enough to have known it, but rapidly becoming a hollow word with but a legendary meaning—SCHOOL SPIRIT.

And now look at the Engineering Society Supply Department! Come with us and have a quiet sleep in one of the chairs whose seats were never cold; rest your feet on the counter, if you like; no one will come in to disturb you. You wish to have a smoke while waiting for Morpheus' arms to embrace you? Ah, my poor fellow, the steps just outside the door are the place for that. How about a chocolate bar or an apple to provide sociable entertain-

ment? No, dear chap, you might forget to throw the wrapper or the apple core into the containers provided for the purpose! Well then, let us while away the time by waiting for something to happen: the first hour—nothing. At ten o'clock ten students, unknown to each other—and to us—enter to purchase lab. covers, drafting paper and one pencil. Exeunt students. At ten-thirty the boy from the press slams a stack of "Varsities" on the table. At eleven o'clock eighty-seven students crowd in, snatch a "Varsity" and flee in haste to enjoy a butt—some before the Mining Building, others on the front steps of the Red School House. (A mild blizzard is raging outdoors.) At twelve o'clock three curve sheets find a buyer. At one o'clock the door is locked. The proceedings during the afternoon are similar—minus the "Varsities."

What has happened? We shall attempt to tell you.

To start with the lesser evil—the abolition of the sale of chocolates, chewing gum and apples by the Supply Department. The boys probably overdid it. Continual eating, chewing and spitting *is* annoying to the lecturer. And to have lecture-rooms littered with waste paper, and lab. floors slippery with apple cores is not a condition stimulating serious effort—all places of work should be kept tidy.

The Ontario Temperance Act, while undoubtedly lessening abusive drinking, failed to retain public support as it failed to accomplish the end for which it was intended: to banish the use of alcoholic drink. And if the O.T.A., an act invented and administered "by the people, for the people," steadily lost the support of its erstwhile advocates, can the arbitrary act of the council of the Faculty of Applied Science and Engineering, imposed upon a supposedly self-governing student body, expect to retain that body's whole-hearted support?

Not long ago the faculty of Princeton University issued a decree forbidding students to use or operate automobiles in or near the university. This open violation of the principles of student self-government called forth the immediate resignation *en bloc* of the undergraduate government. As a protest against this decree, students were seen on the campus on roller skates. School men were deprived of a similar solace: they cannot very well flaunt chocolate cigars in the faculty's faces, since chocolate is as taboo as tobacco! Lollipops might have been a solution. But nobody seems to have thought of it. Besides, we are less demonstrative—although we feel the blight just as keenly.

As for the smoking question:—the one big chief reason for the decree forbidding smoking in all S.P.S. buildings is the very dangerous condition of most of these. Several fires have threatened the School Building during the past four years. The old red brick pile certainly is a fire trap. But that cannot be said of either the

Electrical, the Mechanical or the Mining Buildings. The least fire-proof of these is probably the Mining Building; but it is difficult to understand why, in a place where one hundred Bunsen burners are going at one time (conservative estimate); where combustions, explosions and other destructive phenomena are household words; why, in a hell such as that, say we, a few cigarette butts carelessly extinguished should make such a big difference?

As for the electrical and mechanical buildings—try and set them on fire—even with a blow torch.

Ah, but you forget, will say the black-coated authorities, that this ruling was made only after long and persistent pressure brought to bear by the superintendent of University buildings. The underwriters' requirements demand it. We are helpless.

Please excuse a little digression here. An engineer cannot possibly be expected to have a very extensive argumentative power. He deals with machines and instruments; he may swear at them when they refuse to function; but many a motorist will tell you how much help *that* is. He also deals with men, it is true; but usually, we hope, in the quality of boss. What he says goes (or it doesn't). Whether it does or not, his inflection is imperative.

Now take a doctor; his dealings are exclusively with people; you can't keep a woman from wanting to reduce when she only weighs 130 anyway, by commanding her. You've got to use persuasion. The same applies to most patients. And here we come back and rejoin the old thread of the story.

Our neighbours the Meds must have used an awful lot of persuasion on the Superintendent to obtain permission to have a smoking room in their building, which is not a bit more fire-proof than the Mechanical Building, for instance. But that's where their training tells. They did it. They probably argued him into it, until he consented. No engineer could do that.

It is hardly worth while to mention the U.C. common room, where smoking is allowed. This common room is situated in a structure which will soon be 100 years old, made of wood to a great extent—and of old wood at that.

Let us now recount what has been said, in substance:—As a direct result of the decree forbidding the sale, by the Engineering Society in its own supply department, of sweets, fruit and tobacco, social and informal intercourse between students of all years and departments has been seriously curtailed. Students *will* have their smokes between lectures—the small groups in front of all doors, in the worst weather, are proof of this fact. Since there is no common, congenial room in which this craving may be indulged by all—the indulging is done individually, the scope of the student's acquaintance with other students is restricted. This destroys the spirit of comradeship which may only be fostered by intimate,

daily, informal contact between freshmen and seniors, architects and chemicals.

Let us not be accused of only tearing down, without attempting to build up. The Premier of Ontario, in the last election campaign, was not satisfied with saying that the O.T.A. was no good and had to go. His criticism was constructive. He had another solution to offer.

We do not pretend to have a statesman's sagacity; nor can we lay claim to the mature adult's impassionate reasoning power and quiet deliberation. We merely feel that School men are being wronged, and we humbly beg to indicate a path which might lead to a better understanding between faculty and undergraduates—maintaining the authority of the first, while safeguarding the privileges of the latter.

Another little digression might make the point clear:—The government of Ontario having recognized that absolute prohibition was unenforceable and unpopular, has devised the scheme of submitting the sale of liquor to Government Control. The government's power stops with the legislation. It entrusts the *enforcement* of all details of the law to a commission with very wide powers.

Now the point is this:—Let us have a D. B. Hanna in S.P.S. Legalize the sale and consumption of nicotineous weeds and non-intoxicating food, and let the commission see to it that there is no abuse.

The steps to be taken in order to make this possible would be the following:—

1. The Engineering Society Supply Department should be moved into more spacious quarters in one of the fire-proof buildings —with a view to establishing a common room.

2. The council should except this room—and this room only, from the "No Smoking" Law. Fines to apply to all other places as heretofore.

3. The president of the Engineering Society, the chairmen of all clubs, and the year presidents should use all their influence and vigilance toward the maintaining of decent conduct and orderliness in lecture-rooms and laboratories.

This would constitute the control commission; it would be responsible to the council for the observance, by the students, of all regulations.

4. The regulations and *their reasons* should be explained to the undergraduates by the president of the Engineering Society, in addresses given to each year separately.

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A fine looking man in the prime of life once entered the office of a physician. "Doctor," he said, "my greatest ambition is to live to be a hundred years old. Please tell me what I should do to reach that age."

The medical man was surprised at such a request. However, he carefully examined the patient, and finally prescribed as follows:—

"Firstly, dear sir, I would advise you to give up tobacco."

"Why, doctor," interrupted the centenarian in anticipation, "never in my life will I take up this disgusting habit."

The doctor continued: "Secondly, if I were you, I would drink only very moderately."

"Drink!" exclaimed the patient. "No drop of alcohol has ever passed my lips. I would sooner commit murder."

"Thirdly," concluded the physician, "you should keep strictly away from the fair sex."

"You mean women? They cannot tempt me. I have lived a straight and upright life until to-day. I shall continue to do so."

Here the doctor stopped. Finally he asked: "Will you please tell me why in hell you want to live so long?"

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The department of mechanical engineering maintains a library for the use of students in the third and fourth years. A very useful collection of books and periodicals is on view there. We say "on view," because most of the books can be seen very plainly through the locked glass doors of the shelves.

In many down-town book stores a sign is prominently displayed, inviting the passer-by to "come in and browse around." This enables one to at least establish a nodding acquaintance with books of all varieties.

At the present time the average S.P.S. student wants one of the library books "to look up something," be it for his thesis, a discussion on someone else's thesis—or even because he is genuinely interested. In order to find out what he wants, he must

(a) find the department head's secretary downstairs;
(b) ask her to open the shelves for him;
(c) obtain his information before 5 p.m., unless he wants to take the book home, because the shelves are locked up again at five o'clock.

Would it be possible to allow free access to the valuable material contained in this library, so that one might "drop in" occasionally to turn the leaves of a few books? This is done, for instance, in the metallurgical and electrical libraries. An incredible amount of information is stored up on these shelves. By even furtively going through some of this material, curiosity, at least, is aroused. And this curiosity easily leads to further investigation, and, finally, serious study.

Most School men are inclined to be shy; and they must have an imperative reason before they will go and ask a lady to climb two flights of stairs to open a book case. Neither do they want

to keep a lady waiting after five o'clock—even though they might stay in the building for another half-hour, until the janitor comes around.

Co-operation between staff and students should easily make a more satisfactory arrangement possible.

All of which sounds very reasonable. But just now it has occurred to us that a certain class of students who think that $125 is a fair price to pay for the privilege of smashing perfectly good and useful window panes, might want to see the Old Red School go up in flames, for the thrill of it—even if it cost them a bit more. Or they might also direct their attention to books in the library—float them in the Hydraulic lab. channel, or use them as missiles for interfaculty battles.

Unfortunately there will always be a certain percentage of similar morons wherever more than ten individuals are gathered together. And it is the task of the responsible majority to keep watch over their treasured privileges, by preventing the irresponsible fools from abusing them.

LLEWOH.

*Fighting David's Clan**

I

Now David was a shepherd lad
Who watched his father's goats;
He took good care
To comb their hair;
He fed them bran and oats.

And one fine day as on the hills
He twanged his harp of gold,
A guy appeared
All mud besmeared;
His skin was bare and cold.

"Come David lad and help us all,"
He shouted up the rocks,
"A bloody h'athen
Caught us bathin'
And stole our pants and socks!

So David boy went o'er the hill
And down the slope he saw
A great big lad,
Ten feet, by gad!
A layin' down the law.

"Come on, you shrimps," the giant he yelled
To David's Jewish friends,
"I'll black the eyes
Of both yous guys;
I'll fill your bones with bends!"

Then David stooped and picked a stone
And put it in his sling;
He slowly went
On murder bent;
He never said a thing.

The giant looked up and saw wee Dave;
He laughed and roared and shouted out aloud:
Dialogue
"Sure it's a monkey on a stick I see!"
"I'll knock your bloody head off," says Dave,
"Like h— you will!" says the giant.

So David whirled his sling around
And aimed it at the head;
The rock he threw
It sailed up true
And knocked the giant stone dead.

II

Now David grew to be quite old,
His family was immense;
They travelled free
On land and sea;
They broke down all defense.

Where e'er they went the neighbors knew
That fightin' was their game;
As men who fought
They cared for naught;
They took on all who came.

Then later on as they grew rich,
They bought a coat of arms;
A shield of steel
That made you feel
The motto meant some harm.

For on that shield a legend ran
That made the blood run cold;
Three words were there,
They'd raise your hair
When shouted out so bold.

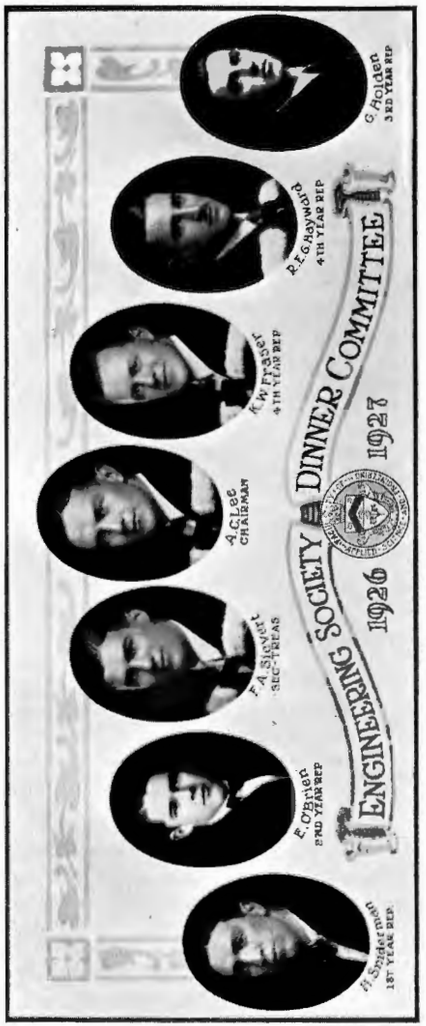
Just Soak'em, Poke'em, Soak'em, boy!
So ran the motto there;
When shouted loud
By David's crowd
It scared the rest for fair.

But one fine day a scholar lad,
He pointed out quite true;
Why shout the words
And scare the birds
When letters three will do?

Just S.P.S. we'll yell it out,
We'll shout it every man;
And all will see
We're strong and free;
We're fightin' David's clan.

RICHARD THOMAS '05.

*With apologies to the author of 'David & Goliath."



The Annual "School" Dinner

On Tuesday, December 7th, the Carls-Rite Hotel was the scene of one of the most successful banquets ever held by the Engineering Society. Students and professors alike sat down to a hearty repast, featured by "chicken, à la Wilkie"—"Spiked Thompson's Celery"—"Tommy Bingham's Ice Cream Creations"—"Coffee by Gad" and last but not least, "Government controlled Ginger Ale."

At the end of the meal, "President" Bingham called on Aub. Sievert to propose a toast to the University, which was very adeptly answered by Sir Robert Falconer.

With the next toast, that to the faculty (and may we remind Monty that the faculty is composed of professors, not buildings), Monty surely excelled himself. The speech, with the exception of the main one of the evening, which was of an entirely different character, was "super-par-excellence"—and Monty deserves all due credit for his wit and humor. The toast was appropriately answered by the Dean, who may always be relied upon to give us something to think about.

We were fortunate in having representatives from McGill, Queen's, and R.M.C. with us. The president (Tommy, himself) proposed the next toast, to our Sister Societies, after which the various representatives were introduced.

Fred Emney, who needs no introduction to School men, was asked to "render" us a few selections, and after hearing his "English-Negro" version of "I Ain't going back to nowhere, 'cause I ain't got nowhere to go," it was more or less unanimous that Mr. Emney should continue for a while.

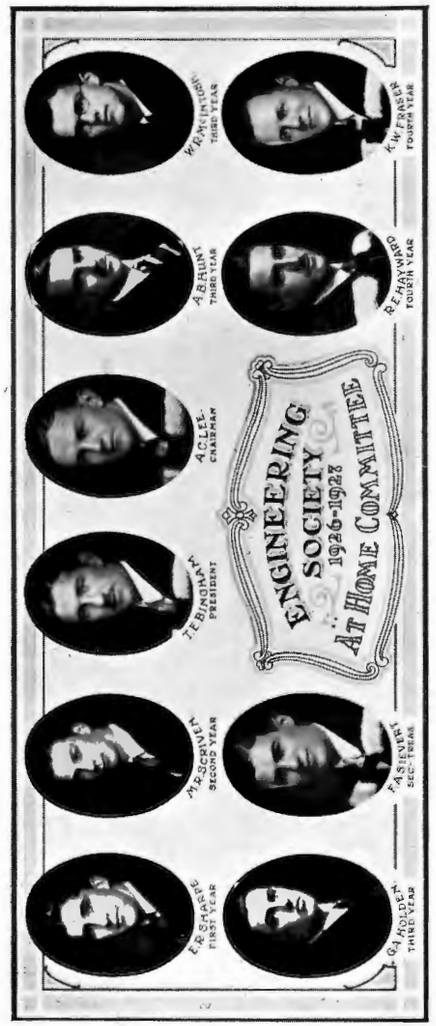
The feature event of the evening took place in the speech by Principal R. Bruce Taylor of Queen's. It was certainly the best after dinner speech that we have listened to, and a speech to even equal it would be hard to find. Principal Taylor used his Scotch wit to great advantage, and he may be assured that his talk was readily appreciated. We take this opportunity to extend to Principal Taylor our thanks.

School was very fortunate in being able to have Sir William Mulock to present his own cup to the Junior School Rugby Team; and his few words concerning sport found an echo in many School men's hearts.

The Dean made the presentation of the trophies to the rowing crew, and then Fred Emney favoured the guests again with a few more songs.

The banquet came to a close with a Toike Oike, and everyone seemed to have enjoyed himself both inwardly and outwardly.

On behalf of the School, we want to take this opportunity of thanking Al. Lee for his untiring efforts in making the banquet a success—for its success was largely due to him.



The "School" At-Home

No Freshman seems ever to want very much to go to the School At-Home. Possibly the reason is that it is much too urbane a party for those who are not certain that they are quite grown up.

This year was no exception to the general rule, and the At-Home was, if possible, more successful than ever before. At least, in no previous year has the Committee permitted two hard-visaged and ill-favored individuals to engage in what seemed to be a gold digging session in the middle of the floor, that pastime being usually left to the possibly more gentle, and certainly more beautiful half of the gathering.

The dancing was done to the seductive fiddling of Romanelli and his henchmen, while the entertainment was sung, acted, grimaced and danced by the "Gentleman from Hamilton," of whom none but the Schoolmen seem to have heard. It is claimed that with sufficient inclination (which, some seem to think, was supplied) his voice will drown out any orchestra that ever "orched." Romanelli claims that no human voice can, when his gang are sufficiently inclined, (and some say they were positively tipped) drown out his Orchestra. However, this is a matter which only those present can decide.

The favors, cigarette holders or perfume flasks, in the form of small dolls, seemed to find much popularity among the beloved of the "Ones with the Hairy Ears."

The Crystal Ballroom needed no decoration other than the School shield, and the food was beyond reproach, the whole eating business being organized to run with satisfaction and dispatch.

The Committee did a good job. Nothing which might contribute to the happiness and comfort of the occasion was left undone. They are to be congratulated.

"School Night"---Feb. 1, 1927

Some thirteen hundred merry-makers, among these many Grads, assembled to enjoy the many diversions carefully planned by the more energetic of School men. And their efforts were certainly applauded by the remainder of School—so much so that everybody was endeavouring to obtain some substantial souvenir of Hart House as a treasure.

The Fourth Year Mechanicals undertook to portray the adventures of Horace, the Freshman who refused to retreat. In the course of this the inner working at a Faculty meeting was divulged to the amused audience. Now we know how we are plucked.

We were fortunate in obtaining with the original cast, the musical comedy, "Rose Marie," which was set up for the evening in the West Common Room. Music, chorus and scenic effects were without parallel; those Miners do make pretty smooth chorus girls.

A variety of attractions were presented in the Midway—Colour Games, Monkey Races, Guessing Contests—and everybody had horns, chocolate bars, and gum. Mr. Auld of the Fourth Year kindly consented to present an act, which proved more than mystifying to the crowd. The celerity with which he extricated himself from a seemingly impossible situation was amazing, to say the least.

The Civil Club portrayed the effect that co-education and the gradual coercion of the students will have on School and its inhabitants in years to come. One scene gave us a glimpse of the good old days when men were men and —. Then the next showed conditions as they would develop in the future. There was more truth than poetry behind it all.

The Chemists dispensed real stuff as unauthorized agents for the new Government Control System. Lots of good things to eat too.

And in the tank was a remarkable collection of Water Babies who performed for the earlier part of the evening. Exhibitions of swimming and diving by the more expert, together with a water-polo game and a burlesque rugby game played right in the pool, formed a very interesting programme.

At ten o'clock there was dancing in the East Common Room and Big Gym, to the tune of Herb. Smith's peppy syncopation, and eats in the Great Hall, à la Fraser.

Our sincere thanks are due Mrs. C. H. Mitchell, Mrs. C. R. Young, Mrs. T. R. Loudon, and Mrs. J. H. Parkin, who acted as patronesses and made the best of what must have been a rather difficult evening for them.

J. Aubrey Sievert.

Engineering Society Elections

School politics was the all-absorbing influence, from 4.30 p.m. Wednesday, March the ninth, until the small hours of the following Saturday. It is doubtful if so many libellous statements have ever before been formulated, in such a short space of time; and it is indeed fortunate that the "School-press" was so fully occupied with the great rush of advertising copy. This fact alone prevented the filing of numerous law suits, which would have been started had a record been kept of these utterances.

Wednesday afternoon several gentlemen presented, by fair means or foul, their credentials to Tom Bingham, who recorded their claims on the small black-board surface of C.22. We would recommend a larger board for any such future functions; lack of space prevented more nominations. It must be said that this was a very "orderly" meeting, kept so by 2T7 stalwarts who found it necessary to administer only one tapping, besides an eviction.

As usual the most coveted office, the S.C.A. presidency, had many aspirants. It was too bad that, after the flood of nominations for this office, only one could be found that was correctly filled out. This meant that this office was filled by acclamation. Several envious eyes even had visions of filling the Dean's chair; but amid a hail of numerous projectiles which had been removed from the nearby seats, these "frosh" resigned. When, finally, Wednesday evening came, nearly every "legitimate" office had at least four worthy claimants.

For the next day and a half, all of the available advertising space was resplendent in its 1927 flood of colour. This colour was all very well; but as a reminder, unless the candidates of the future advertise with the more substantial cigarettes, etc.—they will find a severe falling off in the annual trip to the polls.

On election day, each year held its own meetings, at which candidates presented their credentials. The most noteworthy of these meetings was that held by the graduating year, at which the permanent executive paraded, plus the "also-rans." Those attending this meeting, of course, were very critical, as befitted the occasion, and many characters have been forever blighted.

Luncheon was held in the Great Hall, and then the East Common Room was expropriated. Some there were, who questioned School's right to this room, but by physical persuasion all disputes were settled. "Worky" and some assistants, at the piano, were present to help the vocal ambitions of the day. During the parade to the polls, some of the artistic gentlemen to the north of the campus found it expedient to keep the big oak doors locked during the passing of the procession. 'Twas ever thus.

The polls opened early, in order to give early returns, and to permit some of the favourite playhouses to have increased attendances that afternoon. The "Gayety" patrons undoubtedly were aware that some stupendous world event was taking place; and it is stated that Watson & Co. had a most enjoyable afternoon.

Evening dinner was held by 2T7 in the Piccadilly Tea Rooms, where our diminutive friend from Hamilton, and dancer "Spike" Thompson, provided the entertainment. The rendering of the "Wolf" was a real musical achievement. It is also understood that, on the recommendation of the tea room proprietor, "Bert" Pitt is to become head waiter for "Child's."

The returns were flashed, on the wall of the second year drafting room, for those who could interpret them. During the intervals of waiting, the usual feats of endurance were indulged in, and a fitting repast enjoyed. At 10.30 the "shouting and the tumult died," whereupon everyone dispersed, either to mourn or to rejoice over one of the best parties of the year.

J. H. Fox, 2T7.

Election Results

President ..... W. A. Duncan
1st Vice-President ..... G. S. Adamson
2nd Vice-President ..... I. C. Hardy
Treasurer ..... J. D. Wright
Secretary ..... N. D. Adams
Director of Publications ..... M. J. C. Lazier

CLUB CHAIRMEN

Civil Club ..... M. Smith
M. & M. ..... L. A. Howard
M. & E. ..... A. E. S. Bolton
Architectural ..... C. H. Brooks
Chemical ..... G. R. Connor
Debating ..... R. R. Peterson

ATHLETIC ASSOCIATION

President ..... J. H. Russel
Vice-President ..... W. E. Algie
Secretary-Treasurer ..... J. Goss

STUDENTS' CHRISTIAN ASSOCIATION

President ..... D. S. Laidlaw
Vice-President ..... C. C. Parker
Secretary-Treasurer ..... J. M. Boyd

2T7 EXECUTIVE, PERMANENT

President ..... C. A. Morrison
Vice-Presidents ..... T. E. Bingham
C. B. Pitt
W. E. Weaver
J. Shortreed
G. L. B. Roberts
Secretary-Treasurer ..... J. L. Killoran

2T8 EXECUTIVE

President ..... A. B. Hunt
Vice-President ..... H. N. Magnan
Secretary-Treasurer ..... D. C. Carlisle
Athletic Rep. ..... A. M. Grant

2T9 EXECUTIVE

President ..... G. M. Gray
Vice-President ..... J. M. Keith
Secretary-Treasurer ..... J. E. Hunton
Athletic Rep. ..... C. C. Parkins

3T0 EXECUTIVE

President ..... G. H. McVean
Vice-President ..... R. M. Ferguson
Secretary-Treasurer ..... W. G. Carruthers
Athletic Rep. ..... W. C. Kirkland

HART HOUSE COMMITTEES 1927

House ..... W. I. McIntosh
Hall ..... W. A. Rooke
Library ..... J. L. Davenport
Music ..... G. S. Adamson
Billiard ..... W. C. Caldwell
Sketch ..... J. M. C. Lazier
B. S. Shenstone

The Civil Club

As soon as the boys had become settled once more under the wings of "Good Old School" and seemed to have recovered fairly well from their summer's dissipation, the Civil Club stepped into view. Activities began with a visit to the Lackawanna plant of the Bethlehem Steel Company. We are indebted to Professor T. R. Loudon for arranging this for us. Despite the rain, by bus and car, the Civils headed for U.S. in general and Buffalo in particular, intent on adding to their stock of knowledge the main features in the preparation of the raw materials for our big buildings and bridges. On arrival at the plant, parties were formed and guides from the engineering office took us over the works. We were enabled to trace the products from the ore through all the stages, blast-furnace, ingots, rolls and finally the finished structural shapes ready to be shipped. On the way home a short stop was made at Niagara to see the illumination of the falls. It is rumoured abroad that considerable study was made of shapes other than steel during the sojourn in Buffalo, and it is the common belief that the Americans turn out some fair samples.

Just before Christmas, as is the custom of the Club, the Civils gathered in the East Common Room of Hart House for the annual smoker. The newly organized 3T0 orchestra assisted and put considerable real pep in the evening. With their assistance and that of Doug. Laidlaw officiating at the lantern, melodious were the songs, new and old, that were heard issuing from the assembled Civils. Later in the evening Professor Cockburn gave us considerable enlightenment as to the ways, pleasant and otherwise, of the army mule. Several more or less burlesque boxing matches completed the entertainment. One of the contestants was later heard to remark that he was sure he was kicked by one of Professor Cockburn's mules. This, however, gentlemen, was not a dirty crack about the proficiency of any of our students in Descriptive Geometry. After retiring to the Great Hall and partaking of light refreshments our friends on the staff imparted to us a considerable number of current witticisms.

About the end of January the Club was again called together, and through the aid and courtesy of Professor C. R. Young and Mr. Wass arrangements were made whereby we were introduced

into the inner workings and the construction of the new C.N.R. yards and round-house. After being shown the plans of the track system we were shown through the new buildings, etc., by former "Schoolmen," including such recent grads as H. D. Griffith and Ted Emerson.

The 2T8 Civils very aptly represented the Club at "School Night" and depicted "School" twenty years ago and twenty years hence. The acting would have done justice to Shea's or the Pan with such far famed stars as Mr. McGregor and Mr. Magnan. Mr. Hvilivitsky's crystal gazing was also very commendable, and the whole performance went over big.

The term was concluded with a very successful dinner held in Hart House. The honorary officers of the Club each gave us a few words of wisdom in both poetry and prose in response to the toasts. Then Professor Bain in his usual interesting and entertaining manner gave us an illustrated address on one of Canada's leading industries—the "Production of Wood Pulp." At this dinner we were also very glad to welcome to our table our friend and past chairman, Bert Kribs.

In conclusion let us congratulate Mac. Smith on his election to the chairmanship of the club for 1927-28. We have already felt Mac's presence on the Executive and know that he is a real worker and will give unsparingly of his time and energy to put things over. However, it must be kept in mind that no matter how proficient the man is, little can be done without the whole-hearted support of every member of the Club. So back Mac and see a bigger and better Civil Club.

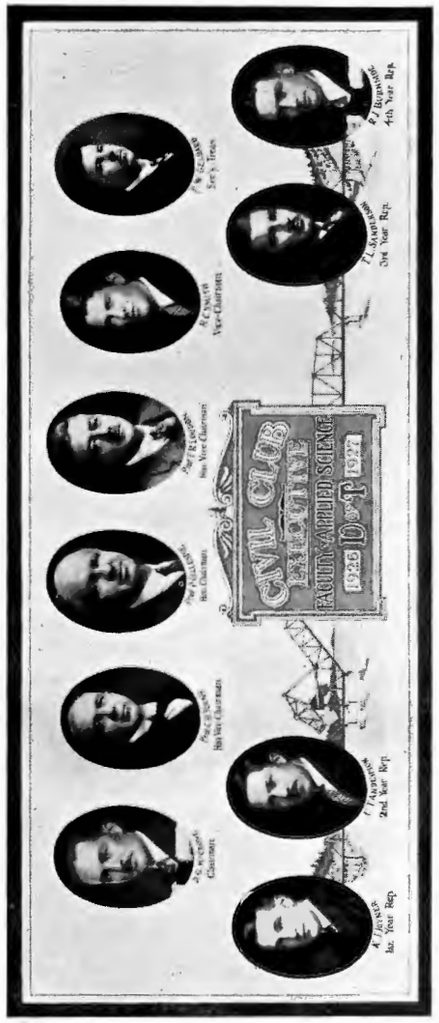
DONALD G. MCCRONE.

Gull Lake

One of the many reasons why the Civils and Miners of the Third Year have the laugh on the other departments is because they spend a month together at the University Survey Camp at Gull Lake, and this month of living and working together does more than anything else to foster the spirit of good friendship between the two departments, which exists in the Junior and Senior Years.

The Miners arrive in camp two weeks later than the Civils, to find all the best beds taken and everything running in pretty fair order. Survey parties consisting of three or four men are made up, and if we had gone out some morning last September we might have found Mac Smith buried in the bush, amusing his party with questionably good stories, or Sunshine trying to run railway curves through a herd of cows or some of the Miners, swearing fluently as they check up a traverse run by the Civils. But why the lone transit up on those rocks? Ah yes! The Four Perfect Virgins!

GULL LAKE



There is no mistaking the smell of Phyl's pipe, and one bush cannot possibly hide all of Lottie's, Toots' and Katie's mining boots!

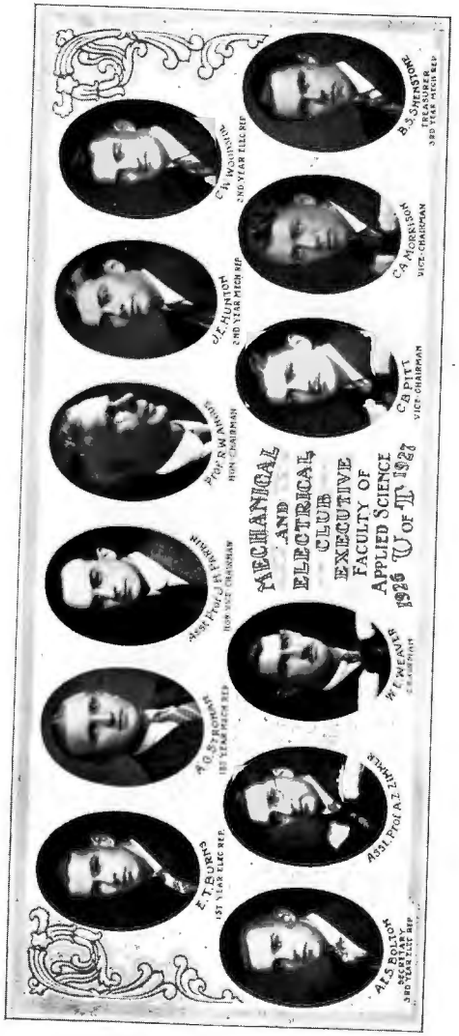
There is always keen competition between the two departments, and although Ash Can Duncan and his team trimmed the Miners at softball every time, the ten Miners proved their superiority on the 30 ft. tower by setting an unbeatable record of one hundred per cent off the top.

The Annual Camp Dance was held on the Friday before Labour Day, and when the boys had finished decorating it, the Bunk House certainly did look nice with the School colours intermingled with evergreen, Japanese lanterns and coloured balloons. Ross Crerar played all the popular pieces on the piano, and everyone had a darn good time. There was a full moon specially ordered, and so somehow the trip didn't seem so long for the boys who paddled their partners home.

The Regatta was held on Labour Day, and in spite of the rain there was a good crowd out. There was the usual amount of spills, and the novelties were quite original. But the feature event of the day was the Staff Punt Race, and although Professor Stewart came in first with colours flying, we wonder what Mr. Melson would have done if he hadn't tried to paddle with only one oar! Bill Duncan carried away the honours, with George Gray place and Louie Howard show; and taking the afternoon as a whole it was quite the success that the Minden Herald had prophesied.

The trips to Minden were not the least part of the day's entertainment, and the Minden Queens were always there, even though they were sometimes in the company of lumberjacks with spiked boots! So the Queens are still waiting, and our only word to 2T9 is "Beware of the B's."

KATIE.



The Mechanical and Electrical Club

The first of October-trips-lectures-exams—the end of April—one more academic year is over, and with it, one more successful year may be recorded for the M. & E. Club.

The first trip of the Club was the annual trip to Queenston. The boys assembled at an extremely early hour at the dock, boarded the boat and were away. What? Land lubbers? No. Just Charlie Morrison and Aubrey Sievert meeting the boys, who for some reason or other decided against the early morning sail. Three hours later the 'Toonerville Trolley' carried us up from the Queenston dock to the Queenston Generating Plant. Upon our arrival there, the party was subdivided into several groups, and we were shown the intricacies of this large and well designed plant. Some of the engineers must have thought we were contemplating the purchase of said plant, but the data included in our reports probably explained why certain individuals were 'pacing' about in a peculiar manner. Lunch hour brought a rush for the elevator—trolley—and the Refectory. No explanation necessary. Thence the party was taken to the intake of the Chippawa Canal, where Professor Taylor very kindly explained the 'whys and wherefores' of the various things seen there. Niagara Falls, New York, and the Niagara Power Company was our next objective. There we were shown 'The largest generators, etc.,' in all the world—the Queenston Plant needed no advertising. The party returned on the evening boat, and Professor Price entertained some of the men with stories, after which we partook of the evening meal. Dusk—The Georges—DeLaplante and Roberts—provided Hawaiian music; then Connor took the helm at the piano.

'Hence the Pyramids'—sorry, my error—'Behind the Pyramids' was the picture presented by the Canadian National Carbon Company (the Pyramid being the company's trade mark) at a meeting of the Club held in room E-23, the first week of December. George Smith has decided that more respect should be given to lamp black in the future—and rightly so.

The latter part of January, the 27th to be exact, the whole club, 150 strong, set forth for Hamilton in five T.T.C. buses. A slight delay occurred at Burlington, where the party was broken up into two divisions, one going to the Canadian Westinghouse, the other

to the International Harvester. Lunch was scheduled for 12.30 at the Bohemian Grill—Everybody there—yes—just a minute, you are wanted on the phone—hello, what did you say? Professor Price and about eight others left at the Westinghouse. Apparently the Bohemian Grill did not fully realize a School Man's appetite; if they did, there most assuredly was no indication of it. In the afternoon, in addition to those plants already visited, those of the Standard Underground Cable Company and the Steel Company were inspected. Six o'clock saw 150 hungry men back at the Bohemian Grill, and from observations one would say Tom Bingham and B. Hunt found other 'attractions' than food. Three busloads returned to Toronto after the meal; the remaining two wanted to see some of Hamilton's 'bum' shows, and their appreciation of same was quite appropriately shown. All returned safely, although 'Bert' Pitt threatened on more than one occasion to remain in Hamilton.

A School Grad, Mr. J. H. Ratcliff, of the Canadian General Electric Company, showed two moving picture films to the members of the Club who assembled in E-23 on the afternoon of February 16th. The pictures were, 'The Conquest of the Forests' and 'Wizardry of Wireless;' the latter film very materially enlightened the members of the club (with special reference to the radio option) on the secrets of radio.

This short retrospect of the Club's activities during the past year is in no wise complete without special reference to the co-operation and hearty good-will that was shown on all occasions. The outgoing executive can only wish 'Stew' Bolton and his confederates the best of luck and success.

W. E. Weaver

MECHANICALS IN THE THERMO. LAB.

Front Row: DeLaplante, Vercoe, Sampson, Hillier, Howell, Jones, Boles, Stanley.
Second Row: Mr. Heard, Chisholm, Clapp, Barr, Bruce, Thompson, Pitt, Prof. Allcut, Mr. Shortt, Sherk.
Back Row: Bicknell, Saunders, Dunlop, Flett, Salter.

The Mining and Metallurgical Club

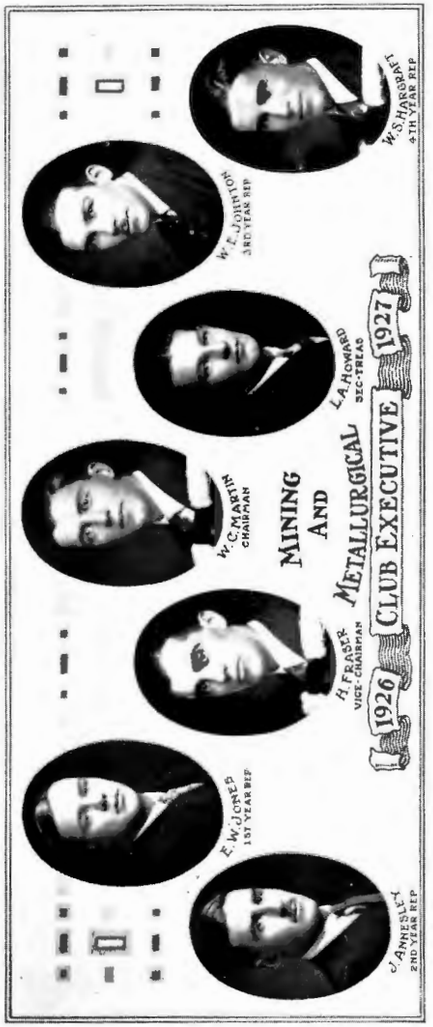
The first meeting of the year was held at Hart House soon after the opening of the term. Business for the coming year was discussed and the frosh duly initiated in the customary manner by a cross examination as to their aims and ambitions in joining the esteemed profession.

About the middle of November an attempt was made to have the latest film of the mines of the Porcupine District released before the Club for the first showing. Unfortunately, the picture was not quite ready, and in place of it some of the old pictures of the Cobalt and Porcupine mines were shown. Professor Parks very kindly gave an entertaining talk on these districts before and during their first growth. He pointed out some of the opportunities which had been missed; doubtless the same opportunities exist to-day in the new camps of Ontario and Quebec.

In the first part of December, Mr. Sutherland, Inspector of Mines for Ontario, gave an instructive lecture on "Silicosis." He made special reference to the work of the mines in South Africa and the present work at the Hollinger. Since then, through Mr. Sutherland's assistance, one of the IV Year miners has become no mean handler of the Konimeter in a theses on Silicosis.

The first meeting of the second term was held in the latter part of January, in the form of a dinner. Mr. Balmer Neilly, Secretary of the McIntyre Porcupine Mines, gave an interesting talk, in which he outlined the history of mining in Canada. He also gave some valuable and excellent advice to the members.

With the characteristic versatility of the M. and Emmers, School Night saw some of the apparently respectable members array their nether limbs in silk stockings, and their upper parts in feminine "what nots" in a musical skit entitled "A Miner's Reverie of Rose Marie." The scintillating beauty of our "Rose Marie," Miss Geraldine Grey; also the notorious Georgina Grey as "Wanda," not to mention the sparkling wit of Crumb Rumsey as "Hoi-man," and the tricky kicks of the chorus girls all combined to make the performance an outstanding success. This was testified by an overflowing house at both shows. We must also thank the rest of the members who took part in this contribution to stunt night, particularly Al. Jeckell for his able directing of the play.



During the earlier part of February, Mr. Sutherland gave the members of the Fourth and Third Years an instructive lecture on Mine Accidents.

In the latter part of February, Mr. Mackintosh Bell honoured the Club by an address in which he described his experience in various parts of the world, including New Caledonia, Australia and Russia.

A meeting was held in the first week of March to discuss summer employment. Members in the Fourth and Third Years outlined their experiences in obtaining jobs at various camps. This was followed by a general discussion on the same topic.

We now hand over the reins to Louis Howard, and feel sure that he will uphold the prestige of the Club during the next session.

W. C. MARTIN,
Chairman.

The Industrial Chemical Club

After the lapse of a whole year we have once more been assigned this page wherein to sum up the activities of the club.

The Industrial Chemical Club started activities for the year with a smoker at Hart House. At this meeting the officers for the year were elected as follows:

Hon. Pres.—Professor J. W. Bain.
Hon. Vice Pres.—Professor E. G. R. Ardagh.
Vice Pres.—G. R. Connor.
Sec. Treas.—W. D. Irwin.
Curator—G. M. Mason.
4th Year Rep.—M. O. Thompson.
3rd Year Rep.—R. E. Hayes.
2nd Year Rep.—J. M. Keith.
1st Year Rep.—R. M. Ferguson.

The election of officers was followed by an address by Prof. J. W. Bain on the advantages and benefits to be gained through belonging to this club. Two papers were read by members of the club in the Senior Year. Mr. C. A. Sankey outlined the various tests by which the manufacture of pulp and paper is controlled. Mr. M. O. Thompson explained how cream is tested by government inspectors.

Unfortunately we did not have the customary trip of Industrial inspection—the reasonable "Skipper" of last year could not be located. Better luck next year.

The first term ended with a smoker at Hart House. An address by Mr. V. B. Lillie, of the Flint Paint and Varnish Company, on "Paints, Varnishes and Lacquers," gave us an excellent bird's eye view of that industry. Motion pictures dealing with the manufacture of carbon were shown by Messrs. Stott and Webster of the Canadian National Carbon Co. The evening was concluded with the usual eats and yells in the Great Hall.

In January a skating party at Varsity Rink, followed by refreshments and dancing at Picadilly Tea Rooms, started the club's activities for the New Year.

The club as official dispensers for "School Nite" kept thirst down to a minimum at reasonable cost.

The combined meeting of the Arts and Industrial Chemical Clubs this year took the form of a smoker in Hart House. Mr. Thurlow of the Wm. Davies Co. read an exceptionally interesting paper on the "Chemistry of Pork Packing" (in which he assured us that, so efficient is this industry, nothing is lost but the squeal). Mr. Perkins of the Arts Chemical Club rendered two vocal selections which were much appreciated. Mr. Perkins was accompanied by Mr. Todd—also a member of the Arts Chemical Club. We were again fortunate in having two interesting motion pictures descriptive of industrial processes. These were shown by Mr. Ratcliffe of the Canadian General Electric Co., and depicted "The Conquest of the Forest" and "The Manufacture of Pulp and Paper."

The annual dinner and concluding meeting of the year was held at Hunt's Tea Rooms. After fully satisfying the inner man, pipes were lit and a few old songs sung by way of relaxation, after which Mr. Ralph Kerr favoured us with a couple of recitations; once again we followed the deeds of "Yukon Jake." The speaker for the evening was Dr. F. W. Atack, president, the Industrial Process Development Limited, Kingston. Dr. Atack chose for his subject, "Reminiscences of Chemical Industry." The most interesting, witty and entertaining talk, together with the sound advice which enriched it, will long be remembered by the members present.

Mr. G. R. Connor proved to be the successful candidate for the chairmanship of the club at this year's election. This year is to be an eventful one in the history of the University, and also this Faculty. Having held the offices of 1st Year Rep., Sec. Treas., and Vice Pres., "Gerry" will without doubt ably lead the club through so important a year. To "Gerry" we hand the reins of office.

J. G. Anderson.

The Architectural Club

We lost five members by graduation, one or two by exams, and yet another to the lure of New York, still the Frosh enrolment brought our number to normal to start the new term.

Our anticipated fall sketching trips were rather a disappointment. The weather man was very unfavourable to us and the majority of our "picnics" had to be put off. We managed, however, to get one in between showers. This will undoubtedly prove a sad blow to the world of art, which has lost many valuable additions as a result.

The new members were duly received into the club in the time honoured manner at our first meeting. This took the form of a dinner at the Five Sisters Tea Room. After the Sophs, led by Johnnie Collins and Art Davison, had made the "poor Frosh" appear more foolish than usual, a fine address was given by Prof. Wright. After welcoming the newcomers to our midst, he gave them some very sound advice as to their conduct as freshmen.

The Club was very fortunate in having Mr. John A. Pearson, F.R.I.B.A., as Honorary Chairman. At our second meeting Mr. Pearson gave a very interesting talk on the new Parliament Buildings at Ottawa. Being the architect for these buildings, he was able to give us many interesting sidelights on the work. His address was illustrated with working drawings, details and photographs. Following this, Mr. Pearson and Mr. Rankin held an open session, answering any and all questions thrown at them regarding the work. This meeting was held in the exhibition room at School, and the afternoon was brought to a happy conclusion with tea served by the ladies of the department under the capable leadership of Miss Lalor.

Our afternoon tea party proved so successful that it was decided to repeat it at future meetings. Mr. Wilson, who has had many years' experience in building superintendence, was the speaker at the next one. He held an open meeting, asking for questions or difficulties which confronted the members. These were fired at him with gusto and the session was undoubtedly of great value to all.

Mr. John M. Lyle, probably Canada's foremost Architectural critic, delivered an illustrated address on Canadian Architecture at our next meeting. This was similar to the address he has given

on numerous other occasions, and which has caused such widespread interest. The substance of this talk will undoubtedly prove of great value to all who heard it.

The judicial powers of the club had to be called upon during the latter part of the year. Owing probably to the fact that their term as frosh was nearly over, the members of the first year (with the exception of the feminine section) took the liberty of absenting themselves from a club meeting. For this they were duly summoned before the court and forced to face certain grave charges laid by prosecuting attorney Raymore. Despite a brilliant defence put forth by Mr. McRae, attorney for the defence, the poor Frosh were found guilty by the jury. The said Frosh were called upon to traverse the hall on all fours lined by armed jurymen and spectators. The ever ready tap was found waiting for them at the farther end.

During the course of the year much joy was occasioned by news received from Fontainbleau, France. At the American Architectural School there, three of our graduates, Messrs. Horwood, Steele and Ryrie, took the three scholarships given. This was accomplished against men from many of the large American colleges, and, we feel, reflects great credit on our school.

We might go on and tell of the hectic trip of the fourth year to that rugby classic at Kingston, or of some of the wild evenings working in the drafting room, or still again of the trip of the third and fourth year to the brick yards, but space is limited and time is short.

The year draws to a close—the frosh will soon be sophs; the sophs juniors; the juniors seniors, and the seniors —? so things go on and all this passes into history. Successful as has been the present year, we look for still greater things during the ensuing year under the able guidance of Charlie Brooks.

R. S. Hanks,
Chairman.

The Debating Club

"Silence is only commendable
In a neat's tongue dried."

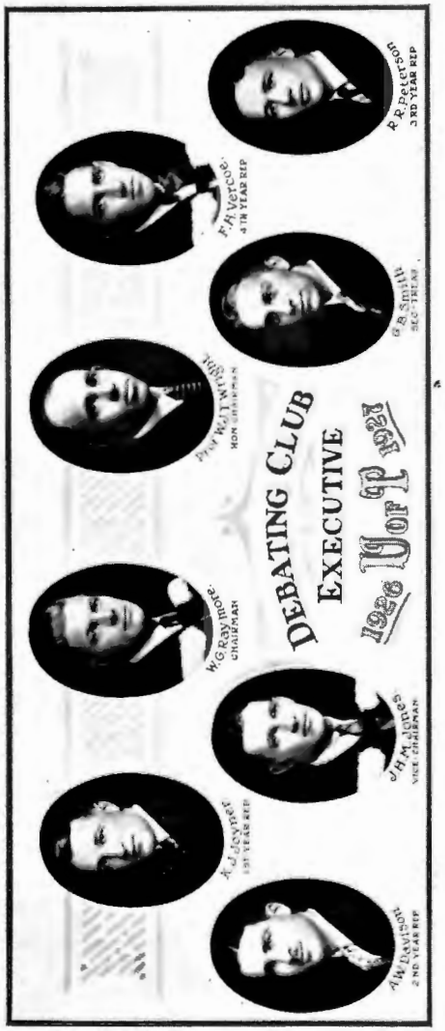
THE MERCHANT OF VENICE.

When the Bard of Avon penned this laconic comment he no doubt had in mind the morrow's bread and the urgent necessity of persuading his noble patron to part with a goodly number of the coins of the realm in exchange for works of alleged literary merit. Or possibly the advance guard of to-day's high-pressure advertising man had just reaped the pecuniary benefit of the Shakespeare genius and William of that house had received as his portion only a hack-writer's wages. Of course we may do that gentleman an injury in imputing to him such mercenary motives, but it may be readily imagined that the poet had learned in the hard school of experience the need for spending almost as much time in devising ways and means of gracefully and effectively introducing himself and his art as he did in scribbling sonnets to the village belle or unmusical comedy for my Lord of Leicester.

While not degrading the art of speaking to the point of measuring it in terms of yellow-backs, the members of the Debating Club have nevertheless realized that facility of expression is indispensable in all spheres of life and not least in the engineering profession.

We are informed on the good authority of that classic scandal-collector, Plutarch, that Demosthenes, most eloquent of the Greeks, used a mouthful of pebbles to good advantage in overcoming certain impediments of speech, and had recourse to such expedients as shaving half his head lest he be tempted to sally forth and neglect the more important matters of enunciation and delivery. The guiding spirits of the Club have not, however, adopted those measures to insure the discipline of the members. They believe that practice is the best medium for overcoming the obstacles to effective speaking, and that the only constraint necessary to lead Schoolmen to participate in the activities of the Debating Club is their own recognition of the obvious need for such training.

The open meetings of the Club have been addressed by an array of able speakers. Professor C. H. C. Wright, on the subject of



"Athletics," furnished interesting material for the ensuing discussion which raged around the question of greater opportunity for every Schoolman to engage in competitive sport and the desirability of making the same compulsory. Professor Angus, speaking on the "Chicago Diversion Problem," recounted the history of that undertaking and showed the absurdity of placing the entire blame for the low water level of the Great Lakes on this project. Professor Allcut on "Depth versus Breadth in a Career" indicated clearly the dangers of over-specialization, particularly in the engineering field, and urged his hearers to participate in interests beyond those vocational, thus tending to a more complete development. The enthusiasm with which the members presented their ideas on these occasions is indicative of the value of this phase of the Club's activity.

The executive of the Debating Club was extremely fortunate in securing Professor Greaves, head of the Department of Public Speaking at Victoria College, for an address on the relation of self-expression to life. Professor Greaves' fund of humor and inimitable manner rocked his audience with mirth and provided one of the high-lights in the year's programme.

Those of an argumentative trend of mind found an excellent outlet for their logic in the Inter-Year Debating Series for the Segsworth Shield. In the first of these the historical antagonists, Freshmen and Sophomores, crossed swords over the resolution that "all forms of compulsory initiation should be abolished in the Faculty of Applied Science and Engineering." The First Year was unable to convince either the judges or their opponents that such was the case, and School is apparently committed to a further "slaughter of the innocents."

The Third and Fourth Years met in the second verbal conflict, in which the former opined "that the number of engineers graduated by this Faculty is in excess of the demand in Canada, to the detriment of the profession." The Seniors, facing the immediate prospect of being thrown out upon an unsympathetic world, battled to prove that they were assets too valuable to be rejected by the captains of industry, and were sustained in their contention.

The final debate centred around that much-vexed question of what the mere male favours in feminine complexion and disposition. The Fourth Year declared "that gentlemen prefer blondes," while the Sophomores championed their brunette friends with equal warmth. It is apparent that the Faculty as well as the undergraduate body is divided on this issue, since the judges indulged in a further twenty-minute debate in private before reaching the decision, which was finally awarded the Fourth Year. The Seniors will therefore have the custody of the Segsworth Shield for the ensuing year, on which will be inscribed the names of R. G. Hillier and F. H. Verco. Those who have represented their respective

years in this series, in addition to the above, are: E. W. Dill and W. D. Sheldon for the Third Year; Messrs. Argo, A. W. Davison, McRae and Jenkins for the Sophomores, and A. L. Watson and K. J. Joyner for the First Year.

In the Inter-College Debating Union, Science debaters were drawn against McMaster University, winners of the I.C.D.U. for seven consecutive years. C. H. Brooks and G. B. Smith of S.P.S. supported the resolution "that it would be in the best interests of the Canadian people that the Senate be abolished." Apparently the judges became panic-stricken at the thought of Schoolmen wrecking the British North America Act and so awarded the verdict to McMaster.

The Annual Contest in Public Speaking offers a means of measuring the degree of success achieved by the Debating Club. The wit and wisdom revealed in the silver-tongued eloquence of this year's competition bears abundant testimony to the efficacy of the Club's programme. D. G. W. McRae of 2T9 was awarded first place and the challenge trophy; G. B. Smith of 2T8 ranked second, and J. H. M. Jones of 2T7 was placed third. The achievement of these members is greatly enhanced when the uniformly fine effort of all the contestants is considered.

The interest and sympathy of the Faculty for the aims of the Club has been particularly gratifying. We desire to thank Professors C. H. C. Wright, Angus, Zimmer, Allcut and W. J. T. Wright for their unfailing courtesy and service to the Club, and especially the latter, whose counsel as honorary chairman has been invaluable.

The number of Schoolmen who have recently bewailed the fact that they have not engaged in debating activities earlier in their academic career augurs well for the continued success of the club next year under the able leadership of Mr. R. R. Peterson, who falls heir to the wisdom gleaned from this year's experiences and the fatherly blessing of departing members.

W. G. Raymore,
Chairman, Debating Club.

Message of the Permanent Executive of 2T7

Shortly one hundred young Engineers (alleged) will be turned loose, to wander over the universe. Our undergraduate life, in a few short days, will be but a fond memory—Yes! All but the examinations. It is with great regret that we leave our Faculty, our University; which to most of us has meant much more than what we learned within its walls.

We, members of the Permanent Executive, realize our responsibility and only ask your faithful co-operation. Already steps have been taken to link this graduating year with the last five to form a sort of "International Science Club," which, if successful, will be of great service to us younger graduating members.

The Alumni are beginning a great work for the "School Man," both graduates and undergraduates. The movement is, through our graduates who have made their mark with large concerns, to raise the standard of wages paid to men on courses, or serving their shop-work. This is but one of the services well worthy of support, and it is the duty of every man in the year to join the Alumni Federation and give it his whole-hearted support.

Now, gentlemen, you have an executive, and we want to be of service to you. For instance, if you are located in a strange city, town or country, write in—Ask if there are any graduates located there; they will be only too pleased to meet you. The writer's permanent address will be placed at the bottom of this sheet. Cut it out and put it in your pocket note book! Also, when you change your address, do let someone on the executive know about it. We want an up-to-date record of this graduating year of 2T7. Be a subscriber to the University Monthly; it will ever be the link between fellow graduates, as well as between you and the University.

We, the executive, wish everyone a most successful and happy future and thank you for the honour you have bestowed upon us. We assure you that we will fulfill our duty and honour your trust if you will give us even half a chance.

So then, brethren, we are not children of the bondwoman, but of the free. Gal. IV, 31.

CHARLES A. MORRISON, Permanent President,
164 Indian Rd. Crescent, Toronto 9.

Permanent Executive Class 2T7

T. E. BINGHAM
Vice-Pres.

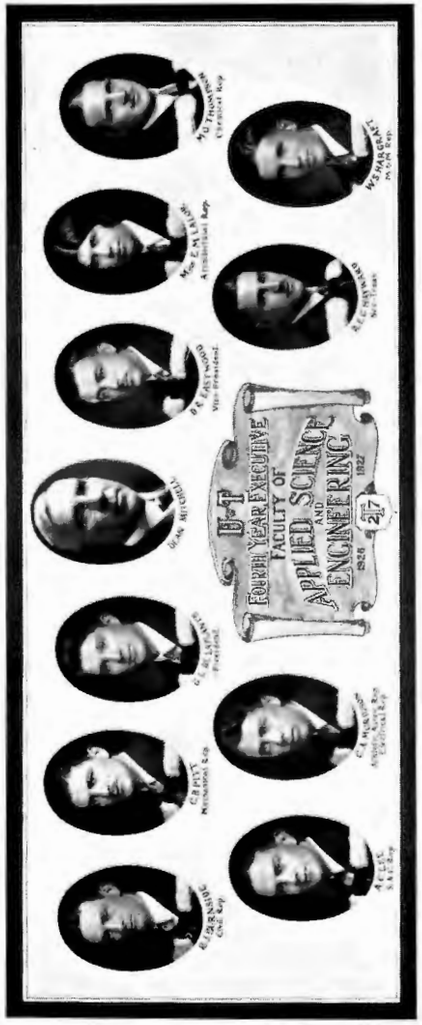
C. B. PITT
Vice-Pres.

W. E. WEAVER
Vice-Pres.

J. SHORTREED
Vice-Pres.

G. L. B. ROBERTS
Vice-Pres.

J. L. KILLORAN
Sec.-Treas.



Graduating Year

As to how applicable is the verse about the fourth year man in the "Psalm of Life," 2T7 is in an excellent position to judge. Athletic and social activities have followed each other in such rapid succession that our final year passed as a dream only to be rudely broken by the discordant and hectic tune of exams. Through the year the chief cause of consternation was the thesis, except in the case of the mechanicals, whose worries in this respect ended with October.

In the social realm, the year was begun with a smoker held in Hart House. The programme comprised an industrial picture and a comedy, downtown entertainment and music. Smokes and eats helped to complete a very successful stag party.

The Senior School Dance, combining the third and fourth years, took place at the Palais Royal on December 3rd. The event was marked by an amount of levity and freedom that ensured a good time for everyone present.

Following closely after "School Night" and the "At-Home" came the Graduation Dance on February 25th. This party was a fitting climax to the social activities of 2T7. Adding to the enjoyment of the evening, a humorous "habitant" poem was rendered by Ralph Kerr, a 2T5 grad, during supper.

On the night of elections, the year dined at the Piccadilly Tea Rooms. Great was the hilarity and fellowship, stimulated and encouraged by our little coon friend from Hamilton.

Athletics, always a major feature in School's activity, received strong support from 2T7. Charlie Morrison has distinguished himself in both outdoor and indoor track meets. "Spike" Thompson, "Aub" Sievert, and "Hal" Vernon have always pulled well for School on the Rowing teams. Water Polo and Swimming have thrived in School, due, in large part, to the efforts of Shortreed, Enouy, Lorenzen and Sampson. Special mention should be made of the achievements of Bill Hargraft in Rugby and Hockey, and of Pug Irwin in Rugby. Ballachey has done good work in Basketball.

A large representation from 2T7 are T holders. The following men have received this distinction—Bruce, Carrick, Hargraft, Irwin, Lee, Lorenzen, McCrone, Morris, Morrison, Shortreed, Sievert, Thompson, Vernon.

The first editor-in-chief of Torontonensis from Science came from the ranks of 2T7. George Roberts has also been a capable and willing worker on School's publications.

To keep us linked together we have our permanent executive under the capable leadership of Charlie Morrison. News will be broadcasted continually by the secretary-elect—Joe Killoran.

ELSIE MacGILL

Our Ladies of 2T7

BETTY LALOR

Astonished were the faces of the men of 2T7 when, as freshmen, they realized that the sanctum of the First Year Drafting Room had been invaded by a bold, ambitious co-ed. The architectural "studios" had been used to the presence of ladies, and Miss Betty Lalor found a ready welcome there. But a lady in that den of iniquity, the first year drafting room? Where was Workey going to tell his stories? What new, polite exclamation of disgust were the poor freshmen to invent, for use when the ink spilled over their paper, in order not to shock the ears of so tender and unspoilt a creature? Would our "Elsie" outlive the freshman year and finally blossom forth as the only female electrical engineer of S.P.S.?

Such questions and numerous others formed the subjects for many heated arguments. They are now settled; events have shown that our worries were futile. Miss E. M. G. MacGill of Vancouver managed to look after herself in so masterful a fashion that, by the time this is published, she will be as good an engineeress as has ever worn overalls—if not better. With clever hand she steered her ship around the cliffs of annual examinations. With true womanly grace she kept in check those fellow-students who dared disregard the respect due to so frail a creature. So well did she uphold her dignity that one day, in a lecture, the boys were rudely awakened from their slumber by the unmistakable sound of two feminine hands coming into very sudden contact with two masculine cheeks.

Although Miss Betty Lalor's career at S.P.S. was perhaps less momentous, it was nevertheless a distinguished one. Throughout her course a most useful and active member and executive of the Architectural Club, Miss Lalor has achieved a degree of proficiency in her chosen work which will, we are certain, enable her to play an important part in a profession for which there is such a large field in Canada, and on the whole continent.

2T8 Third Year

At the first general lecture of the Fall term the proposed year budget and year fee was presented for approval. The year voiced their approval of the fee by a large majority, practically unanimously. This method of procedure seemed to find favour, as the secretary's report to date shows 104 fees paid out of a possible 106.

The year dance held at U.T.S. on Nov. 26 was a departure from recent custom, the last year dance being held by 2T4. Those present were unanimous in acclaiming it a very successful party, the absentees being the losers.

The annual Senior School dance at the Palais Royale was as usual a gay night. Many were heard to remark that it was the best Senior School dance of late years.

On Tuesday, Jan. 25th, we staged our year party. The general programme of the party of last year was followed, as it seemed to meet the approval of all. The year is to be commended on their conduct during the presentation of the play. Engineers have always been noted for their ability to adapt themselves to all circumstances, and we sincerely hope that no action on the part of School undergrads will ever give anyone the impression that S.P.S. men cannot act as gentlemen when the occasion demands it.

2T8 took a prominent part in School Night this year. Besides the numerous men of the year on the committee, our Gull Lake Civils staged a little skit depicting School 20 years ago and then 20 years hence. It proved quite successful and compared favourably with the other skits of the evening.

In athletics the year has, as ever, been quite prominent. While the Senior School teams in rugby, hockey, baseball and basketball were not very fortunate in their endeavours, it could not be said that it was from lack of third year support. Especial mention must be made of the honour conferred upon Francis Trimble in being elected captain of the Varsity Rugby team for this year. We are all proud of Fran's playing last year, and we wish him a Dominion Championship this year. Mention must also be made of Jim MacKenzie, Individual Intercollegiate Track Champion.

The executive wish to thank all the members of the year for their whole-hearted support, and I personally wish to thank Mo Campbell and Arnie Grunsten for their loyal help at all times. Of Arnie Grunsten as secretary one might say "There is none better."

In conclusion we wish you all success in the coming exams and the hope of reunion in the Fall. We pass on the torch to "B" Hunt, Harold Wagnan and Don Carlisle, 2T8's fourth, last and most promising year executive.

W. A. DUNCAN.

2T9

We have spent another year here, and little we seem to know about engineering. However, our interests are too varied to let that darken our thoughts. Right from the first we had to divide our attentions and show the "Frosh" how to wear the "green tie" outside, to show a little respect to the traditional School buildings, and remove hats, if any, and the discarding of any toggery such as bow ties, spats, hair-lips, etc.

However, one October morning the Frosh showed they did have some spunk. In a very bold and daring manner, they walked right down the main steps of the Mining Building. Unfortunately (or fortunately?) the Sophs were not on the scene. But something must be done! So Woody staged a Wild West Show in the Engineering Building a few days later. The Waterworks Department were notified, and the Frosh got a general clean-up. Some say it was only "hygienically"—but we have our doubts!

During the excitement of last October, a very sad affair took place in the Second Year drafting room one evening. We had to initiate the frosh. But we are not assuming the responsibility for its success. If we had only realized our position, the Freshmen would have been invited to take tea with us at the Faculty Tea instead.

On November the 16th, the Frosh squared things with the usual Banquet. The Prince George tried to spread itself on $1.50 per, and everyone enjoyed the function to the fullest. Congrats, Frosh! Prof. C. R. Young, in his usual jovial manner, addressed the gathering and made the banquet a very interesting affair.

At this point, it seems quite fitting to express our appreciation to the Junior School Dance Committee for their efforts.

The theatre party at the Empire will not be forgotten for some time. Darts of all kinds were hurled about to the tune of Toike Oike and Henry VIII. "Tons of Money" was not so attractive as the leading lady. We surely should have had her picture on J. J.'s desk! Although there were some things kind of bum—for which we are sorry—the supper at Hart House and the entertainment were really enjoyed.

Then, one evening we got a glimpse of some lady friends of two-tee-niners. The Party at U.T.S. showed just what could be done if we tried! And we think the girls had a good time too.

We wish Gerry every success this coming year, and we shall all be behind him in everything he does. He will be assisted by Jack Keith, Vice-President, and Johnny Hunton, Secretary-Treasurer.

JACK DEACON, *Pres.*

The Junior School Dance

In trying to meet with the same success as last year, financially, etc., the Junior School Dance was again held at the King Edward Hotel, January 17th. Romanelli seemed to excel himself, and very excellent music was provided.

The Pompeian Room was gaily decorated with wind-bags of assorted and divers colours. Unfortunately these were all broken during the dance! Many novelties were introduced after supper and made the party very lively. Although the lemonade was consumed in 4.73 minutes, many, if not all, enjoyed the supper.

3T0

On the day of September 25 there enrolled as members of 3T0 the largest class ever known in the School since 1923. They were large in more ways than one, as the Sophs soon found out. Yet, being of a good nature, they were more or less submissive to the biddings of their senior years.

Initiations being banned, and the Sophs being handicapped thereby, the Freshmen were persuaded to initiate themselves. This they did by putting on a programme of skits and stunts which was held in Examination Hall. The price of admission to each man was his green tie.

The Soph-Frosh Banquet was held on Tuesday, November the sixteenth, at the Prince George Hotel. The banquet was well attended, not only by the Sophs and Frosh, but also by numerous representatives of Third and Fourth Years. Prof. C. R. Young was the speaker of the evening, and gave an interesting address on "Items of Interest to Engineers." Worky was given his usual seat of prominence at the head table, and amused all with his latest stories.

The Junior School dance was held January seventeenth in the Pompeian Room at the King Edward Hotel. A record crowd made this event a great success.

3T0 Smoker was held in Hart House on February 25. Skits, pictures and stunts made up the programme. Worky was on deck to put the sing-song over. Lunch was afterwards served in the Great Hall.

3T0 is prominent in many circles in the University.

"Blondy" Kirkland, who is a member of the Intercollegiate Boxing team, upholds their good name in the ring with success.

Harry Sniderman is rated as the fastest Basketball player on the Intercollegiate Basketball team. Harry surely shows his stuff.

In gymnastics there are the Hyslop Brothers, one of whom is a member of the gym team.

In short, 3T0 may be found represented anywhere. They are undoubtedly strong enough and talented enough to hold the good name of School as high as it has been held before.

The year in all its activities has been a great success.

The incoming executive are: G. H. McVean, Pres.; W. E. Carruthers, Vice-Pres.; R. M. Ferguson, Sec.-Treas. We expect this executive to boost 3T0 to the limit.

N. D. Adams, Pres.

SNIDERMAN

SCHOOL ATHLETICS, 1926-27

The School Athletic Association

As the end of the term draws near it is with a feeling of satisfaction that we review School's athletic activities for the past session. It is true that in other years we have won more of the cups emblematic of interfaculty championships. We do not, however, measure success by that alone. When every man is giving his best for School and really playing the game, nothing better may be desired.

We have three championships as a result of the year's activities. The Junior School Rugby team turned aside all comers and carried off the Mulock Cup, the most famous and coveted of all interfaculty trophies. It has become quite the custom for our crew to win the interfaculty regatta, and this year was no exception. The Eckardt Cup for water polo is in our keeping this year, due to the great work of the Junior School swimmers. It is the first time in some years that we have had our hands on this; let's hope it stays for a while.

While these are our most successful teams, others have made their presence felt in the various branches of athletic endeavour. Of these, the soccer team is especially worthy of mention.

The Swimming, Soccer, Track and Rowing Clubs did excellent work this year. The Boxing, Wrestling and Fencing Club was revived and staged a very successful inter-year assault, at which several promising men were discovered. If we could only have such organization and activity with respect to rugby, hockey, basketball and baseball, the detailed work of looking after these sports would be well provided for, and the executive of the Association would have more time for other necessary business.

The $2.00 fee which came in this year certainly removed a great deal of worry with regard to finances. We have been able to loosen up when necessary, without misgivings. It was felt by many that more pictures of School teams would help to make a better Torontonensis, and we have put in several more than we were able to do formerly. We felt that teams, which in other years had suffered from lack of adequate equipment, did not do so this year. Our financial troubles seem to be over for good.

The plan of giving certificates with "Faculty Colors," brought in last year, is an established fact, and this year all men granted "S"'s will receive a certificate when the Colors are presented. The list is not complete, as yet, but it is expected that more than fifty "S"'s will be granted.

Some mention should be made of our "T" holders, who bring much fame and honor to our Faculty by the splendid manner in which they represent the University in the many branches of inter-collegiate competition. Fourteen of them graduate this year. Their loss will be felt, but we hope that others will come forward to uphold the standard they have maintained so well.

The financial statement of the association is given below:

ASSETS	
Balance 1925-26	12.55
Mulock Cup series	23.43
Fees	974.00
Total	$1009.98
EXPENDITURES	
To "S"	153.75
Torontonensis	60.00
Rugby	176.90
Hockey	102.96
Track	38.00
Basketball	44.15
Indoor baseball	8.05
Swimming and water polo	69.50
Rowing	25.85
Soccer	82.15
Sundries—	
Dr. W. Thompson	25.00
Dr. W. Hill	25.00
Western Hospital	2.00
A. R. Gilchrist	10.00
Stamps, etc.	1.00
	$824.31

In a short time now we shall turn over the job to Harley Russell and his executive. Harley is well prepared for the position, having served on the executive as vice-president, and Secretary Treasurer. Two others have also had previous experience in this work.

The executive wish to express their thanks to the managers of the teams, who have done a great deal towards making the year the success it has been.

A. G. BALLACHEY,
President S.P.S. A.A.

"T" HOLDERS IN S.P.S.

Vernon (Rowing), Irwin (Rugby), Carrick (Rugby), McKenzie (Track), Lee (English Rugby), Duncan (Rugby), Shortreed (Water Polo), Morrison (Track), Trimble (Rugby), Sievert (Rowing), Parkinson (Fencing), McCrone (Gymnastics), Davenport (Track), Thompson (Rowing), Nimmo (Swimming), Battye (English Rugby), Goss (Swimming).

School in Intercollegiate Sport

Once again School comes to the fore in supplying captains for the various intercollegiate teams.

In Rugby, Hockey and Track there were School men chosen to lead—Trimble in Rugby, Kirkpatrick in Hockey, and McKenzie in Track.

These three men have been leading in their various sports since coming to School, and have greatly helped to keep School where she is in intercollegiate athletics.

Besides these three men there were many others who have made a name for themselves in the intercollegiate field; and a very short list of who they are and on what teams they have played is found below.

Intercollegiate Rugby

"Fran." Trimble (Captain 1927-28)—Star half back. In his third year.

"Jess" Carrick—Middle wing, and also a hockey player of note. In his fourth year.

Senior O.R.F.U.

"Cal" Calnan—Regular middle wing player; also on the wrestling squad. In his third year.

George Gray—Middle wing for two years on the team; also a third year man.

Track

McKenzie—Captain for next year and hurdler on the team. In his third year.

MORRISON

RUSSELL

Russell—Winner of the 100 yards, and next year President of the School Athletic Association. A third year man.

Charlie Morrison—Another sprinter of note, who showed his heels to many. Graduates this year.

"Alec" Grant—the long distance man. Three miles is his speciality. Has another year at School.

Swimming and Water Polo

John Goss—who has broken three Canadian records this year. He has two more years to go.

Nimmo—Goss's year mate; also good in the short distances.

Shortreed—The long plunger who won in the intercollegiate meet. He also played on the water polo team. In his last year.

Thompson—Commonly called "Spike." Played on the water polo team; was also on the rowing crew. He graduates this year.

Rowing

Scotty Bruce—Was on the crew that went to McGill this year. Formerly played rugby, but gave it up this year. In his last year. "Scotty" was also on the crew.

Hockey

"Heck" Kirkpatrick—Captain 1927-28 and regular defence man; mainstay of the team for two years. In his third year.

Boxing, Wrestling and Fencing

"Blondy" Kirkland—Made his name by winning his bout at Annapolis. A first year man.

Calnan and Martin were the two wrestlers on the team. Both are third year men.

Parkinson and Dyment were the two fencers and held their own with the best in the sport. Parkinson is in his fourth year and Dyment in his second.

Basketball

Harry Sniderman was the only member from School, but he made his presence known. He is also quite a ball player. In his second year.

JUNIOR SCHOOL RUGBY TEAM—MULOCK CUP CHAMPIONS

Back Row: Colombo, Langford, Strong, Hardy, Kearns, Joyner, Wilson.
Front Row: Emerson, Lamond, Sharp, Green, Woodside Lewis, Furber, Meikle, Carruthers.

Junior School Rugby

After one of the most successful seasons in history, Jr. School brought home the Mulock Cup again to the resting place it knows best.

Crowning a campaign during which they suffered not a single touchdown to cross their line, they gained a 1—0 victory over Dents to win the most coveted inter-faculty trophy.

Although a very late start was made in practising, the natural ability of the players carried the first couple of scheduled games, until the team, by dint of daily workouts, good coaching and being hounded out to practice regularly by their self-chosen manager, began to gain momentum.

During their group games three wins gave them the honours, after which a close 2—1 contest was dropped to Junior U.C.'s strengthened team.

Entering the play-downs, all players tended strictly to their knitting, and by exercising due control over that bane of good teams, the over-confidence complex, turned in splendid 14—0 and 15—0 victories over Forestry and Pharmacy and finished up as stated by sliding in at home plate to gain a close 1—0 decision from Dents' good team. The championship game was staged on a miserable, mucky field and was well played under such circumstances. Certainly School was breathing a lot easier after Alf. Hancock's lusty boot from the 25 yard line crossed Dents dead line, and this indeed proved to be the only counter of the affair. The tide was a shifting one, the advantage seeming to change quarterly, and found Dents pressing at the close.

A few more words will close the season. The presentation of the Mulock Cup was made by Sir William Mulock at the Annual Engineering Society Dinner, and at the same time the boys showed their appreciation of Coach Bill Duncan's and Manager Woody Woodside's yeoman service.

As mementos with which to remember a splendid campaign, the regulars will have their S's and all the boys the crests, presented by the University.

A good portion of the championship line-up will be on hand to bring laurels to S.P.S. next fall.

Line-up—Clark (Capt.), Hancock (kicker), Kearns (quarter), Lewis, Meikle, Wilson, Green, Ferber, Lamond, Hardy, Emerson, Crerar, Campbell, Strong, Sharpe, Butler, Carruthers, Colombo, Joyner, Langford, Duncan (Coach), Woodside (Manager).

Senior School Rugby

School never seems to have much luck with her Senior Rugby. Perhaps this is due to the hardness of our work, which does not allow sufficient time for practising. In any case we didn't do so well this year; and, although several of the games were close—that's about all we did.

Not enough praise can be given to the men who turned out so consistently. And if a little more School spirit were shown by more men, Senior School might do considerably better.

The team: MacDonald, McLaren, Chisholm, MacKinnon, Scarth, Hill, Morrison, Carruthers, Hall, Quance, Hunter, Ballachey, H. C. Smith.

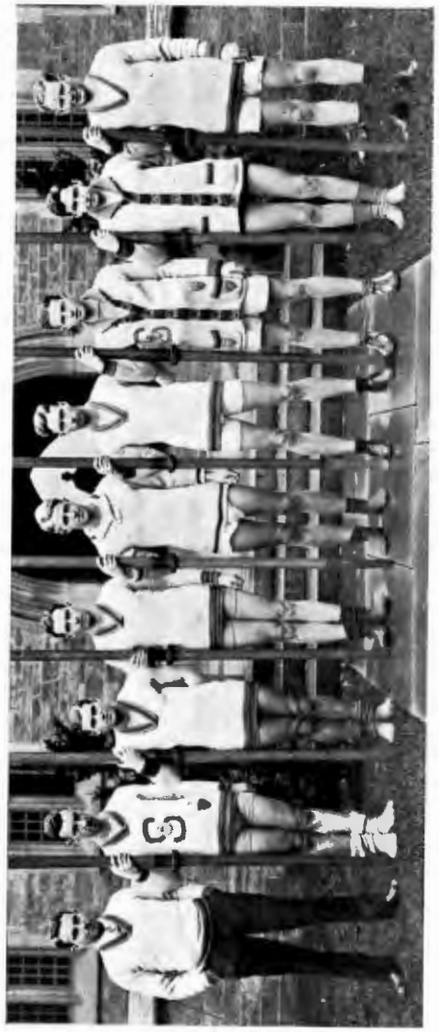
Rowing

Once more the S.P.S. Rowing Club brought honour to School by winning for the fourth consecutive year the Interfaculty Championship, defeating with reasonable ease the other entries.

At the first of the year there was a certain confusion about the Rowing Club. For the first time an Intercollegiate race had been planned with McGill, and with preparations and training proceeding for this, there was very little time left for consideration of Interfaculty crews. Incidentally, School was well represented on this crew that went to Montreal.

However, with the other Faculties all anxious to take from School its rowing title, it behooved us to get busy and build up a crew in defence. The result was that on Regatta Day we were all set to go. School was drawn in the first heat with Victoria, who proved to be no mean contender. Although the bay was a little windy in the early afternoon, by the time the two boats set out for the starting point at the foot of Church Street perfect conditions prevailed. At the start both crews pulled well, but School, swinging long, slowly and easily, gradually pulled out ahead, finishing a good three lengths to the good.

The second heat, between Meds and U.C., promised to be interesting. U.C. apparently had a good-looking crew, which rowed well together. However, contrary to our expectations, after leading at first, their fast stroke began to tell on them, and Meds with a slow stroke gradually picked up, sliding over the finish line a bare length ahead of the frantic U.C. boat. After allowing sufficient time for the crews to become rested, Meds and School set out to determine the championship. Both crews looked like winners with their long, slow stroke; and for the first part of the race they



SCHOOL CREW INTERFACULTY CHAMPIONS
Vernon, Campbell, Sievert, Jones, Kirkland, Davison, McRae, Wright, Boyd.

were neck and neck. However, School, swinging beautifully for such a "green" crew, stepped out ahead at the half-mile mark, crossing the finishing line a good two lengths ahead of the Meds, to the tune of a hearty "Toike Oike" from the ardent supporters on shore.

So School won again, adding another nick to our record. Although for the greater part of the training period the weather was, to say the least, inclement, the old fighting School spirit brought the lads out morning and night, greatly simplifying the work of those in charge of the crew.

Water Polo

The Junior School Polo Team showed themselves to be the class of the University this year by winning the Eckhart Trophy for the championship from Senior Meds, who were last year's champs.

The School team was very fast, the forward line of Goss, Nimmo, Thwaites and Moore being the fastest in the series, while the checking of the defense made some intercollegiate men worry for a while. All but three of the right men were newcomers to the game, and showed what can be done if the players want to work. The following men receive their School "S" for their sterling play:

John Goss, Harold Nimmo, Jack Thwaites, Dean Irwin, Doug. McCarthy, Lorrie Bullen, Pat Grant, Stan. Moore.

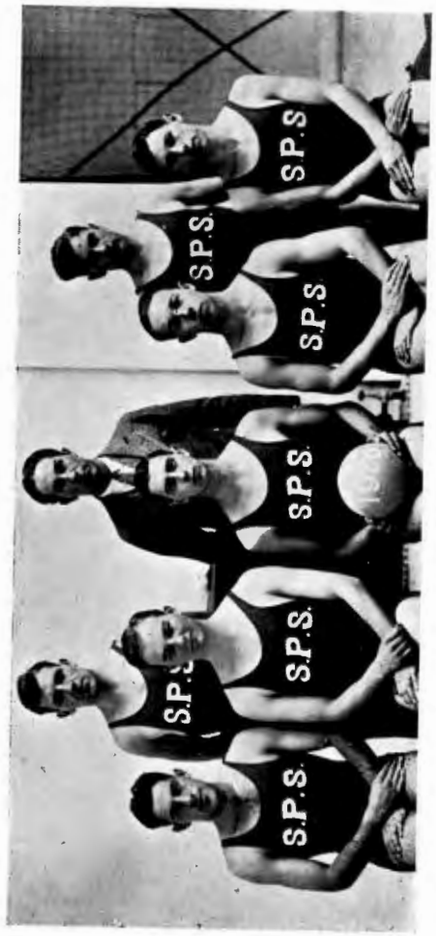
The Senior team had a lot of bad breaks, but kept Sr. Arts out of the finals by defeating them in the first game of the year. For the first time in years a good turnout was maintained throughout the season, and the newcomers will all be going strong at the beginning of the next season. "Spike" Thompson, "Mike" Farah and Len Richardson were the best for the Seniors, Spike going to Montreal with the Intercollegiate Polo Team to win his T for his third sport.

W. G. Enouy,
Manager, Jr. S.P.S.

Association Football

For some inexplicable reason the School Soccer team has failed, of recent years, to live up to the high standard set in other branches of sport, and at first glance the season of 1926-27 bade fair to be no exception to what was becoming almost an accepted rule. For in the first Interfaculty game Vic won without difficulty to the tune of 4—0.

Disaster loomed large on the horizon, when suddenly some bright spirit discovered that amongst the multitude of green decked



JUNIOR SCHOOL WATER POLO TEAM

Back Row: J. Thwaites, W. Enouy, D. Irwin.
Front Row: S. Moore, D. McCarthy, L. Bullen, P. Grant, H. Nimmo.
Absent: J. Goss.

frosh there lurked a diminutive and somewhat retiring youth, Jim Downing by name, who was quietly turning out with the Varsity team and acquiring for himself quite a reputation as a left winger. Another bright spirit discovered for us a goaltender of no mean order, who for three years has been hiding his light under a bushel —to wit that ornament of the Fourth Year, John Howell. The pair of them fitted beautifully into the two most vulnerable positions on the team, and the transformation became evident a week later when School tied into Vic again and trimmed them 3—2 right on their own mud pile. "Mud pile" is no exaggeration either—it had been raining for 24 hours.

With this victory under their belts, the boys proceeded, in the next two games, to take the measure of Dents and Meds. Then Dents defaulted a game, for reasons best known to themselves, and the last game with Meds ended in a scoreless draw—the whole providing a total of points, exceeding Vic's total by the small but sufficient margin of one.

This landed School in the semi-finals for the first time since Moses was a lance corporal, but, unfortunately, confronted with a fast and snappy team from O.A.C., School failed to deliver the goods. Sad but true. The first game, played in Toronto, was nip and tuck, O.A.C. scoring the lone goal of the game. But in Guelph, where frankly the contour of the ground is sufficient to disconcert any visiting team, the Aggies clinched the round by scoring three goals and shutting us out. However, as O.A.C. dealt even more faithfully with Wycliffe in the finals, the boys felt that though defeated, School was not disgraced. And mark you, when it comes to Soccer those "farmers" certainly "know their onions."

Unfortunately graduation removes half a dozen of our regulars, but those who remain hope that with the assistance of 3T1 the School team of 1927-28 will emerge on the long end of the score in the final game of the series. Meanwhile, good luck to those who graduate this spring!

The following is the personnel of the 1926-27 team:—

Goal—J. E. Howell.
Backs—W. A. MacKay, H. N. Magnan.
Halves—G. L. De Laplante, M. O. Thompson, R. J. Burnside.
Forwards—J. A. Downing, W. F. Shields, W. S. Campbell, G. L. Roberts (Capt.), J. D. Haggart.
Subs—E. G. Wyckoff, E. C. Grass.

H. N. MAGNAN, *Manager*.

Tennis

The Interfaculty Tennis Tournament was held last fall, on the courts of the Toronto Tennis Club, and in the latter part of the draw some extremely good tennis was witnessed.

Unfortunately, the entry from School was not very large, and it seems a pity that in a faculty of our size more interest is not taken in a game which, apart from the exercise obtained from it, is of great value in other ways.

Russell Armstrong, one of School's most promising racquet wielders, made the best showing of the entry from S.P.S. He progressed to the third round, and was eliminated by J. Copeland, a very steady player, after a hard three set match.

Harold Magnan, probably our best man, was unfortunately not able to enter on account of the press of academic work, and so one promising entry was lost.

Doubtless because we all work hard, both in the school term and the holidays, accounts for the fact that the majority have not the time necessary to develop a good game, but we hope that our delegation next fall will be larger, and that some representative from school will make the Intercollegiate team.

R. G. ROBERTSON.

Track Athletics

Where! Oh, Where are our track men gone. For years and years the "School" track team has been unbeatable. Last year we dropped back one notch when we lost the "Lanky Rowell" Cup. This year we took another flop and lost the "Toronto Cricket Club" Cup as well. Yes! our honours, both outside and in Hart House, are missing. Our only consolation, however, is that in D. J. McKenzie and C. A. Morrison we have both the outdoor and indoor individual champions, scoring 13 and 23 points respectively.

The Track Club this year offered a new design of the school medal which has been accepted by the Athletic Association. This medal is said to be the most outstanding design of the season, and should be the objective of every man in school. It can be won with our present material, with a little concentrated effort.

At our Soph-Frosh meet last fall, we had some fine material unearthed. But much to our displeasure we have seen very little of these men around the indoor track. If you are to be a good track man you must take advantage of the indoor coaching. A month of training in the fall will never develop you into a "Star" or even a "winner."

Next autumn we will only have Russell, McKenzie, Grant and Davenport of our old team. It is up to men like Dyment, Joyner, Woodside, Mason, McVean and Emerson to get busy, train earnestly all summer, and come back, ready to take advantage of our expert coaching. These men and others can and must do it if school is to remain peer of the campus sports.

On the Intercollegiate track team there is a wonderful opening for men who can put the shot and throw the discus or javelin.

SCHOOL SOCCER TEAM INTERFACULTY SEMI-FINALISTS

Back Row: G. L. DeLaplante, W. A. Mackay, J. D. Haggart, W. S. Campbell, J. E. Howell.
Front Row: G. Wyckoff, W. Shields, Prof. E. A. Allcut, G. L. Roberts, N. H. Magnan, M. O. Thompson, J. A. Downing.

Surely School among her mighty men of 3T0 can produce such a man. Gentlemen, it is a real chance for your "T."

Next fall there will be arrangements made for those who take part in *any* sport to be excused from laboratory work at 4 p.m. This is a long needed stimulant for our athletics. Now it is up to you fellows to take advantage of this offer from the Faculty—and to show them that this is what was really needed—as even those pompous and stately gentlemen have noticed the decided lack of interest taken in the sporting life of our faculty.

True—track work is a grind, unsurpassed by any other sport. But always keep in mind that in obtaining proficiency on the cinder path you attain something else that is rarely developed in any other line of athletics—an objective, a sense of responsibility, a something that will bring a track man to the fore in future years.

The Track Club wishes our two graduating members, as well as the whole graduating class, the utmost success in whatever walk of life they may choose—and hopes that in future years they may come back, enter the stadium in the early days of October and watch with that fond parental feeling, the Old Red Building's stalwart bearers of the blue, white and yellow flash first across the finishing line—to the glory of the best faculty of this splendid University of ours.

C. A. Morrison,
President of S.P.S. Track Club.

Boxing, Wrestling and Fencing

Although having been troubled with the sleeping sickness for a year, the School B. W. & F. Club has finally recovered and has more than made up for its year's rest.

However, in that year a few individuals managed to keep School well to the fore in University fistic contests. Messrs. Loscombe and Howard hammered all and sundry from the other faculties, and finally ended by having to play undertaker to each other. They seemed to be fairly evenly matched, for first it was one who represented Varsity and then the other.

This year the club again came to life with a bang, due to the initiative of A. G. Grant, who started the ball rolling. It seemed to get into everyone's blood, as was evidenced by the great number that entered the inter-year assault.

This proved to be a real slam-bang affair, and although not all of the contestants were rivals of Tunney, they made up in enthusiasm for what they lacked in condition and technique. Those who attended as mere spectators spent a very enjoyable evening, but those who were contestants had even more fun, for theirs was a vital interest.

Some very promising material was uncovered, and this early meet also gave the men a chance to limber up for the inter-faculty.

Here again School made it well known that School's men are most at home when employed in the gentle art of war, "whose motto is meekness and peacefulness."

Kirkland of the first year, who was a boxer of note before he came to School, stood out like a red bow tie at a Quaker's meeting. His victories are as numerous as the Duke of York's titles.

Calnan, the strong silent man, annexed enough silver to make him independently wealthy. And Parkinson and Dyment could cross blades with any of Sabatini's creations and teach them a few points in the game.

Here are some of the men who represented School this year on Varsity's B. W. & F. teams:—

Boxing

Kirkland—Guelph, Westpoint, Annapolis. Won all three. He was outpointed by a narrow margin in the Senior Assault by Fiddler. But next year we expect to find him first in all events.

Wrestling

Calnan—Guelph, Westpoint, Yale, Senior Interfaculty, Intercollegiate, Y.M.C.A. light-heavy. He won everything with ease.

Martin—Senior Interfaculty, Intercollegiate. An old hand at the game.

Furber—Junior Interfaculty, Guelph. A very neat wrestler with good form, excellent condition and promise of going far.

Fencing

Dyment—Guelph, Westpoint, Yale. Won easily.

Parkinson—Senior Interfaculty, Intercollegiate.

This is certainly an imposing list of victories, and goes to prove that, where there are things to be done, School will do them.

D. C. Carlisle,
President.

Senior School Baseball

In Interfaculty Sports "Indoor Baseball" has always aroused keen interest amongst players and fans; this year has been no exception. The series this season was divided into three groups, Sr. School being grouped with Sr. Meds, Sr. Dents and Sr. U.C.

Owing to a late start in rounding up our fellows, Sr. School were somewhat handicapped in their first game, which they lost to Sr. Meds. The bad start-off seemed to linger with them all through, and they finished without a game to their credit. The final game with Sr. Dents was the best of the group, and School-

men made the tooth-pullers earn their place as leaders in the senior group.

The interest in the sport is again evidenced by the number who turned out for the games. The following men were out for one or more games: Mac. Smith, Harry Smith, G. B. Smith, W. A. Duncan, W. G. Burns, A. J. Irwin, G. M. Galimberti, D. J. McKenzie, C. A. Morrison, R. S. Hanks, H. N. Magnan, R. W. Welland, G. R. Gray, J. Breckenridge, G. L. McDonald, and T. J. Granton. The number of men who will be carrying on next year bespeaks a strong team for Sr. School.

RICHARD P. QUANCE,
Manager Sr. School.

Junior School Baseball

The Junior School Baseball team, under the management of Harry A. Sniderman, had a very successful season, with the exception of a little hard luck at the first of the year. There was a good turnout to all practices, and after much work the following composed the regular team: Geo. (Scotty) Clark at first base, G. H. (Jerry) McVean holding down second, Armstrong jumping around at short stop, and (Red) Kearns at third. Those residing in the outer garden (?) were Harmer in left, Higgins at centre, and Skey in right field. The battery consisted of Harry Sniderman, who is rated as one of the best, if not the best, softball pitcher in Canada. Behind the plate J. W. S. (Ferg.) Ferguson tried hard to get his hands on the occasional fast shoot of Harry's. Due to Sniderman's activities on the Intercollegiate Senior Basketball squad, we were not fortunate enough to have him with us for all our games. However, Armstrong did the twirling very acceptably during his absence.

The subs themselves were very strong, and there was a good number to choose from. They were: Edwards, Graham, Switzer, Carruthers, Thomas, Hancock, and W. S. (Bill) Campbell.

Bill and Jerry McVean should have a good race for second base next year, as they are both good second basemen.

Senior School Basketball

The Sifton Cup has passed on for another year, and though School had two strong teams, they were doomed to disappointment.

In December the Senior School prospects did not look very good, due to some of the previous year's team having graduated. When the team lined up for its first game, however, it showed up very well, due to the enthusiastic captain, Alex Ballachey. A number of the good players, from the previous year, who had been counted on, were unfortunately unable to turn out, having lost considerable time in the fall, due to Rugby. Nevertheless, all of School's games were closely contested, and it was only with difficulty that Sr. School was finally eliminated.

The team was made up of: Ballachey, Hanks, Swortman, Burke, Smith, Quance, Faber.

Next year we must make every possible effort to bring home the Sifton Cup again, along with other trophies which have been missing from School this year.

B. EDMONSON, *Manager.*

Junior School Basketball

This year was the first in many that Basketball has not prospered around School. Unlike the Seniors, who had plenty of good material which did not turn out (for very good reasons, no doubt) the Juniors simply did not have the players to draw from.

However, a very energetic club of players was worked into a pretty fair team and plenty of enthusiasm shown throughout the season.

With lots of practice under their belts, the boys first stowed away St. Mike's by a margin of 29—10 and proceeded to clean up O.C.E. 17—6. The third game also went into the win column 20—16, and, with the group apparently cinched and all eyes cast on the playoffs, our short-sighted heroes stumbled over O.C.E. 8—15 in the final group game.

Then, by a crowning stroke of injustice, the boys were ordered to play off the group with O.C.E., who had not completed their schedule, and (excuses, perhaps, but true) with the lanky centre, Wilson, in bed, the backbone of the defence, Strohan, with a broken finger, and Captain Collins' hand in a cast, they were nosed out by two measly baskets.

Thus was a season, brilliantly begun, ignobly ended and the team forced to hang up its togs for the year, when they had thought their playing merely begun.

Line-up—Collins (Capt.), Parkins, Wilson, Strohan, Shiells, Rapsey, Lake, Heslop, Ing, Lewis, Woodside (Manager).

Senior School Hockey

School were not as fortunate in hockey this year as along some other lines of sport.

Senior School started off like champions, winning the first game from Senior U.C. quite easily. However, after making a good start, a combination of hard luck and strong opposition caused

School's downfall in all five of her remaining games by narrow margins.

Senior Meds proved much too heavy for School, but even so the "Doctors" could only pick up a three goal advantage in their two games.

While Senior Dents were not as heavy as Meds., they made up for this in speed and team play, and School was forced to take the short end of the score in these two games.

The fact that School and Senior U.C. broke even in their games speaks for itself.

Several of the School team will carry marks of the fray for some time. Too much credit cannot be given to the players for sticking with the team to the end. It was no lack of effort or good players that caused our downfall, but rather a lack of competent coaching. However, School was never noted for quitting, so all we can say now is, "Better luck next time."

The players representing Senior School were—Hall, Jim Auld, Chisholm, Flintoff, Gray, Wideman, Linke, Sherk, Bill Auld, Jones, MacKinnon, Swartman,

Many of these men will graduate this year, but we can feel sure that those who remain, together with any new blood from Junior School, will ably uphold School's reputation of hard workers and good sports whether winning or losing.

H. E. Saunders,
Manager, Senior School.

Junior School Hockey

Although not winning the championship, Junior School ably upheld the traditions of "School" by defeating Junior Arts. Individually the team was strong; but, due to lack of practice and the fact that the players had never played together before, team play was somewhat lacking. School fighting spirit compensated for this, however, and the rest of the teams in the group always knew afterwards that they had been in a game with "School." For some reason or other Jr. Dents did not show up for the last game of the year, and this game was awarded to Jr. School by default. Great promise is held out for the team next year, as the great bulk of the team was composed of first year men. Members of the team were:—Champagne, Allen, Meikle, Chisholm, Reid, Higgins, Smith, Haggart, Skelton, Pinkerton.

T. Bouckley, *Manager.*

English Rugby

English Rugby, alias Rugger, is one of the few intercollegiate sports, which has no interfaculty teams. The classification may be

"intercollegiate," yet as soon as rugger is mentioned, one visualizes a team of fifteen pushing and puffing stalwarts, the most of which bucking and blowing is created by stalwarts from "School."

Varsity's hold on the intercollegiate championship was severely jolted by McGill this year; a tie on the round, being the result of the home and home games. Although Varsity still holds the "cup," it is by the thinnest of threads,—beware the ides of November 1927.

The team this year was at least sixty per cent. "School," mostly men of 2T7. The club was very ably led, by the one and only Al Lee, who filled the dual role of player and Club President.

It behooves the younger athletes to look into this most interesting branch of sport, and to be prepared for the faculty series which is to be organized in the very near future. Moreover, Varsity must regain her hold on the slipping silverware.

Those who are graduating will always be boosting School's efforts for a rugger team; there is plenty of material, so let's go.

J. H. F.

S.P.S. Swimming Team

After U.C. School comes first in Interfaculty Swimming Meet. It was very unfortunate that a man could not enter in more than two events plus the relay team, because if this had been allowed, School would certainly have taken the cake.

The Team

J. M. Goss—Winner of the Durnan Trophy, 1926-27; Canadian record holder 50 yd. free style; Canadian record holder 100 yd. free style. (Mr. Goss is also a diver of no mean repute.)

John Shortreed—Intercollegiate long plunge champ., 1927.

W. G. Enouy—who helped in the relay race and was captain of the team.

H. W. Nimmo—member of the Intercollegiate team. A very fast swimmer. To beat Nimmo a man must equal the record.

I. Lorenzen—Captain of Intercollegiate Water Polo team. Made his brother Fran. step to win the 100 yd. breast stroke.

J. Thwaites—A promising swimmer, but inexperienced. Next year Thwaites will be a star.

J. A. Williamson—Made his debut as a diver only this year and promises to be a winner next year.

From looking over these names, it is seen that School men form the backbone of the intercollegiate team and that many stars are in the process of being developed.

F. A. Sampson, *Mgr.*

BALANCE SHEET OF THE ENGINEERING SOCIETY U. OF T.

As of February 28th, 1927.

Current			$8,222.67
Cash		$ 333.71	
Bank (Current)		1,431.60	
Bank (Savings)		1,890.29	
Victory Bonds		1,500.00	
Accounts Receivable	$283.44		
Less Res. for Bad Debts	66.12	217.32	
Athletic Club		25.38	
Employment		60.00	
Prepaid Publication		48.75	
Prepaid Telephone		33.50	
Mdse. Inventory		2,682.12	
		$8,222.67	
Fixed			344.29
Offive Equipment		334.29	
Smoking Room Equipment		10.00	
		344.29	
			$8,566.96

Liabilities

As of January 31st, 1927

Current			$1,781.74
Accounts Payable		$ 622.79	
Dance		796.61	
School Night		362.34	
		1,781.74	
Capital Account			$6,785.22
Capital Account		$5,774.25	
Profit and Loss Account		1,010.97	
		$6,785.22	
			$8,566.96

BALANCE SHEET OF THE ENGINEERING SOCIETY U. OF T.

Operating Account

For period ending February, 1927

Mdse. Inventory March 31st, 1926	$2,500.00	Sales	$6,820.48
Mdse. Purchases	5,775.34		$6,820.48
	$8,275.34		
Less Inventory February 28, 1927	2,682.12		
	5,593.22		
Add Salaries	451.00		
	6,044.22		
Gross Profit to Profit and Loss Account	776.26		
	$6,820.48		

Profit and Loss Account

Publications	$186.20		Gross Profit Trade Acc.	$776.26	
General Expenses	420.19		Interest & Discount	52.15	
Dinner	114.35				828.41
Grants	22.70				
		743.44			$828.41
Net Profits Cfwd.		84.97	Net Profit Cfwd.	84.97	
		828.41	Fees	926.00	
Net Profit to Cap. Account		1,010.97			1,010.97
		$1,010.97			$1,010.97

"This sort of thing can't go on," announced the two hundred and forty pounder as she tried to struggle into her slim sorority sister's one-piece bathing suit.

"Why do you suppose that fellow's running back and forth in front of the voting booth?"

"Oh, he's probably just exercising his franchise."

"The next person to interrupt the proceedings will be sent home," declared the irate judge.

"Hurrah!" shouted the prisoner.

"I'm doing research work."

"How's that?"

"I'm working with the sheriff. He stops the cars and looks for liquor. I'm a little further down the road and I research them."

"How do the Tau Rho's rate around here?"

"Rotten; their mortgage isn't as big as ours is."

(Octopus)

ECONOMY

A Scotsman was leaving on a business trip, and he called back just as he was leaving:

"Good-bye all, and dinna forget to tak' little Donal's glasses off when he isna' looking at anything."

The height of optimism:

A 100-year-old gent buying a new suit with two pairs of pants.

The man of the hour's opinion of himself is never minute.

(Texas Ranger)

Soon we expect to hear that someone framed the 1918 series of the World War.

The man who used to live from hand to mouth now has a son who lives from gas station to gas station.

"Come on," muttered the condemned convict, as the executioners seemed in no hurry to spring the trap, "I can't be hanging around here all day."

(Louisville Satyr)

She was only a private's daughter—but, oh, say, what a Kidd!

(Cincinnati Cynic)

"Hello, where did you get the overcoat?"
"Oh, about three parties ago."

(M.I.T. Voo Doo.)

"I know a girl who plays the piano by ear."
"S'nothing—I know a man who fiddles with his whiskers."

(Amhust Lord Jeff)

"Waiter, are you sure this ham was cured?"
"Yes, sir."
"Well, it's had a relapse."

(Blue Bucket)

Said the young girl to her dinner partner who has just spilt some salt down the back of her dress: "Oh, now, you can't catch me that way!"

A monologue is a conversation between the man who went to Europe and the man who remained behind.

(The Juggler)