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# The Canadian Engineer

*A weekly paper for Canadian civil engineers and contractors*


# English and Canadian Concrete Regulations

**Comparison Between Toronto's By Law Regulating Reinforced Concrete Construction and the New By-Law Recently Adopted By the London County Council—London Adopts 180 lbs. per sq. in. Shearing Stress and Favors Hooking the Ends of Reinforcing in Beams**


**By W. W. PEARSE, C.E.**

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COMPARING the new by-law or regulations adopted by the London County Council with By-law No. 6401 of the City of Toronto (both of these by-laws relate to the regulation of reinforced concrete construction within the municipal limits), the writer finds that in a great many cases not only the Toronto practice but also the American practice varies considerably from that adopted in London, England.

It will be noticed in the following tabulated comparison that the London shearing stress is given as a maximum of 180 lbs. per square inch, while Toronto gives 150 lbs. per square inch. Chicago gives 120 lbs. per square inch and New York 120 lbs. per square inch, but these two cities state that this may only be used when all the diagonal tension is taken up by the steel.

None of these by-laws give formulæ for figuring the diagonal tension, and in fact most of the authorities on the subject confess that it is practically an indeterminate question. Prof. Talbot, in Bulletin No. 67 of the University of Illinois, states on page 9:—

"It is evident that the value of the diagonal tension is generally indeterminate. No working formulæ are available. For this reason it is the practice, now becoming nearly universal, in beams without web reinforcement to calculate the value of the vertical shearing unit-stress, $v$, and to use this as the measure or means of comparison of the diagonal tensile stress developed in the beam; with the understanding, of course, that the actual diagonal tension is considerably greater than the vertical shearing stress. It has been found that the value of $v$ developed in beams will vary with the amount of reinforcement, with the relative length of the beam, and with other factors which affect the stiffness of the beam."

The formula given by Prof. Talbot, and usually adopted, is:—

$$t = \tfrac{1}{2} f \pm \sqrt{\tfrac{1}{4} f^2 + v^2}$$

where $f$ = intensity of horizontal fibre stress,
$v$ = intensity of vertical or horizontal shearing stress at point in beam.
$t$ = diagonal tension.

The London County Council apparently figure their shear considering it to be a lattice girder, the compression being taken by the concrete and the tension by the steel rods. This appears to be a more reasonable method of looking at the subject, as it gives a very complete method of calculating the tension in the steel.

The compression in the concrete, taking a 1:2:4 mix as the basis of our discussion, is not as high as what we are allowing in Toronto, as we have adopted practically the Chicago by-law, which allows 700 lbs. compression for the extreme fibre stress in bending, and 18,000 lbs. for the steel, whereas London only allows 600 lbs. for the concrete and 16,000 lbs. for the steel.

We make the proviso, however, that where 18,000 lbs. is used, the elastic limit of the steel must be at least 54,000 lbs.

London's method of figuring the resisting moments are what are generally adopted universally by all authorities. They give a table showing certain values for concrete columns in which they state that the helical is the most effective, the circular hoops being next in value, allowing the least values for the rectilinear sections. Our by-law does not cover this point so thoroughly. The London by-law gives a straight-line formula for pillars and columns which varies considerably from what is given in Toronto's code.

Referring to the reinforcing in beams, London seems to lay great stress upon the ends of the reinforcing members being hooked. When this is done they allow considerably higher values than when the rods are straight. Up to date, no extensive tests have been made in America, so far as I am aware, which will verify the adoption of much higher stresses when the material is hooked.

Bulletin 67 (page 63) and Bulletin 29 (page 50) of the University of Illinois, give a few cases where the ends have been hooked, but the results do not seem to bear out the London County Council's conclusions on the subject.

Hool, Volume 1, recommends that the ends be hooked, but does not give any data showing the difference in strength when they are hooked and when they are straight.

Taylor & Thompson, in their 1916 edition, page 419, give some tests conducted by Prof. Bach in 1908 and 1912, in which the professor is of the opinion that the hooking of the rods prevents the slipping of the bars almost as much as 50%, and thereby increases the strength of the beams considerably.

The London County Council's Code compares very favorably with any of the American by-laws, and no doubt there are a number of places in Toronto's proposed new code where we may adopt certain regulations given in the London County Council's Code.

Following is a detailed comparison of the London and Toronto by-laws, the numbers in parentheses indicating the number of the section of the by-law to which reference is made, for instance (108 Sub 2) meaning sub-section 2 of section 108 of the Toronto by-law, and (30-31) meaning sections 30 and 31 of the London by-law:—

[Note—Acknowledgment is due Mr. W. A. M. Cook, formerly of the Toronto City Architect's Department, for valuable assistance in comparing the two codes.—Author.]

| | REQUIREMENTS OF TORONTO BY-LAW | | REQUIREMENTS OF LONDON BY-LAW |
|---|---|---|---|
| | **Effective Span** | | |
| (108 Sub 2) | Clear span and effective depth or length c. to c. of supports. | (30-31) | Same as Toronto. |
| | **Bending Moments for Uniform Loads** | | |
| (109 Sub 1) | WL/8 for non-continuous beams and slabs. | (34) | Same as Toronto. |
| (109 Sub 2) | ±WL/10 for beams and slabs continuous over two or more supports. | (35) | + WL/10 near middle end span.<br>— WL/10 support next to end support.<br>+ WL/12 at middle of interior spans.<br>— WL/10 other interior supports. |
| (109 Sub 3) | WL/9 for beams and slabs continuous over one support only. | (35) | WL/10 at support next to end support (WL/9 for L. L. and WL/10 for D. L.).<br>WL/10 near middle of span (WL/10 for L. L. and WL/12 for D. L.). |
| | | (36) | Also beams may be designed for exact theoretical moments. |
| | **Rectangular Slabs Reinforced in Both Directions** | | |
| (109 Sub 5) | Steel may be reduced 25% from ¼ point to support. | (37 Sub b) | No reduction provided for. |
| | Load on longer supports = $L^4/(L^4 + B^4)$. | | Same as Toronto. |
| | Load on shorter supports = $B^4/(L^4 + B^4)$. | | Same as Toronto. |
| | Length of slab not greater than 1½ times width. | | Length of slab not greater than two times width. |
| | No provision made. | (39) | Beams and slabs to be designed for worst possible conditions of loading. |
| | No provision made. | (41) | Reinforcements to be carried past point of inflexion a length equal to ½ effective depth of beams. |
| | **Working Stresses** | | |
| (110) | Concrete 1:2:4. | (42 Sub a) | Concrete 1:2:4. |
| (110 Sub 3a) | Extreme fibre stress 600 lbs. | | Same as Toronto. |
| (110 Sub 3b) | Direct compressive stress 450 lbs. | | Direct compressive stress 600 lbs. |
| (110 Sub 3c) | Shearing stress 40 lbs. | | Shearing stress 60 lbs. |
| (110 Sub 3g) | Bond stress 60 lbs. for plain rods. | | 100 lbs. for rods hooked at both ends. |
| (110 Sub 3h) | Bond stress 100 lbs. for deformed rods. | | 60 lbs. for rods anchored at ends. |
| | N = Es/Ec. | (43) | Same as Toronto. |
| | Compressive stress in steel N times stress in concrete. | | |
| | Tensile stress in steel 16,000 lbs. | | Same as Toronto. |
| (110 Sub 5) | Provision to be made for eccentric loading. | (44) | Same as Toronto. |
| | Combined stress not greater than allowable working stress. | (46) | Same as Toronto. |
| | Hooks or anchorage not required. | | All reinforcement to be hooked. |
| | No provision made for hooks. | | Bond stress in stirrups neglected if hooked. |
| | N = 15 for 1:2:4 concrete. No value given for other mixes. | (54) | Valve of N = 9,000 divided by working stress in compression. |
| | **Spacing of Rods in Beams and Slabs** | | |
| (106 Sub 14) | 2½ times diameter. No maximum. | (58 and 75) | 1″ clear horizontally and ½″ vertically. |
| | | (59) | Maximum vertical spacing 6″ clear for tensile reinforcement. |
| | **Hooped Cores in Beams** | | |
| | No provision made. | (63) | Where concrete in compression is hooped at ends of beam allowable stress same as in hooped column. |

| | REQUIREMENTS OF TORONTO BY-LAW | | REQUIREMENTS OF LONDON BY-LAW |
|---|---|---|---|
| | **Compressive Reinforcement** | | |
| (110 Sub 16) | Stress = N times stress in concrete if properly anchored. | (61 a, b) | Stress equals N times stress in concrete if bars are anchored by bars extending through a depth equal to arm of resisting moment and spaced not greater than arm of resisting moment and not greater than 16 times diameter of bar. |
| (110 Sub 16) | Stress = N times stress in concrete as above. | (62 a, b, c) | 16,000 lbs. in steel if resistance of concrete is neglected and anchored not greater than 6″ and not greater than 8 times diameter of bar and hooked over both compressive and tensile reinforcement. |
| | **Shear** | | |
| (110 Sub 3c) | Area not mentioned. | (64) | Calculated on compressed area of web or on b j d. |
| | Bars not required to be bent. | (65) | 50% of bars to be bent up where concrete takes all shear. |
| (110 Sub 3d) | All diagonal tension taken by steel where unit shear is greater than 40 lbs. | (66) | All diagonal tension taken by steel where unit shear is greater than 60 lbs. |
| (110 Sub 3d) | Maximum shear 150 lbs. on effective b j d. | (66) | Maximum shear 180 lbs. for 1:2:4 concrete on effective section. |
| | **Spacing of Stirrups** | | |
| | Not greater than ¾ depth. | (67 Sub a) | Not greater than arm of resisting moment. |
| | | (67 Sub b) | Must extend to centre of compression. |
| (110 Sub 3d) | Must be passed around tensile steel and rigidly attached if inclined. | (67 Sub c) | Must be passed around tensile steel. |
| | Maximum bond stress not to be exceeded. | (67 Sub d) | Must be hooked at both ends. |
| | No provision made. | (68) | Bent rods may be taken as shear reinforcement. |
| | **Splays and Brackets** | | |
| | Not mentioned. | (70) | Splay at end of beam to increase resisting M not greater than 30 deg. to horizontal. |
| | **Minimum Depth of Floor Slabs** | | |
| | No limit but stresses and fireproofing. | (72) | Effective depth of floor slabs not less than 3″. |
| | **Minimum Diameter of Rods in Slabs and Beams** | | |
| | No limit. | (56 and 73) | Reinforcing bars not less than ¼ inch. |
| | **Maximum Spacing of Tensile Steel in Slabs** | | |
| | No limit. | (77) | Not greater than 12″ and not greater than 2 times effective depth of slab. |
| | **Distributing Bars** | | |
| | Not required except for temperature. | (78) | Required at 18″ centres and area 0.08% of effective section of slab. |
| | **Resisting Moments** | | |
| (108 Sub 1) | Same as London. | (80) | Same as Toronto. |
| | **Width of Flange of T-Beams** | | |
| (109 Sub 8) | Five times width of beam and projection not greater than 4 times thickness of slab on each side. | (82) | ¼ effective span of T-beam, or 12 times the thickness of slab. |
| | **Width of Flange of L-Beams** | | |
| | No provision for L-beam. | (83) | Four times thickness of slab. |

| | REQUIREMENTS OF TORONTO BY-LAW | | REQUIREMENTS OF LONDON BY-LAW |
|---|---|---|---|
| | **Minimum Width of Stem of T- or L-Beams** | | |
| | No provision. | (84) | ⅓ depth of rib below slab. |
| | **Minimum Width of Rectangular Beams** | | |
| | No limit. | (85) | L/B not greater than 20. |
| | **Reinforcement in Flange of T-Beams** | | |
| (109 Sub 9) | An effective metallic bond to be provided between beam and slab, also transverse bars in tops of flange of girders. | (86) | Slab steel must cross full width of flange. |
| | **Columns** | | |
| (110 Sub 6) | Effective diameter = distance outside to outside of longitudinal reinforcement. | (99) | Same as Toronto. |
| | **Least Diameter** | | |
| (110 Sub 10) | Least effective diameter to be 8″ and area 64 square inches. | | No minimum given. |
| | **Rectangular Columns** | | |
| (110 Sub 9) | Four rods required. | (101) | Same as Toronto. |
| | **Round Columns** | | |
| | Not mentioned. | (102) | Six rods required. |
| | **Minimum Diameter of Rectangular Hoops** | | |
| (110 Sub 8) | ¼″ diameter. | (103) | 3/16″ diameter. |
| | **Circular Hoops** | | |
| (110 Sub 8) | ¼″ diameter. | (104) | ⅛″ diameter. |
| | **Spacing of Bands** | | |
| (110 Sub 8) | Not greater than 12″ or effective diameter. | (105 a, b) | Not greater than 6/10 effective diameter or 16 times diameter of vertical rod. |
| (110 Sub 7) | Spiral reinforcement spaced not greater than ⅙ of effective diameter and not greater than 3″ and volume to be 1% of core. | | Not greater than 3/10 effective diameter at ends. Volume to be ½% of core. |
| | **Size of Vertical Rods** | | |
| (110 Sub 9) | Not less than 9/16″ round or ½″ square. | (108) | Not less than ½″ round and not greater than 2″ square. |
| | **Area of Vertical Reinforcement** | | |
| (110 Sub 9) | Not less than 1% hooped core. | (109) | Same as Toronto. |
| | **Joints** | | |
| (110 Sub 13) | At floor levels or laterally supported points. | (110) | Same as Toronto. |
| | **Rectangular Pillars** | | |
| | No provision. | (112) | Cross ties required where d = 1½ b. |
| | **Column Formulae** | | |
| (110 Sub 3i) | $P = 450 (A_c + 15 A_s)$ for banded columns with 1% to 4% vertical reinforcement. $P = 650 (A_c + 15 A_s)$ for spirally hooped columns with 1% longitudinal steel and 1% spiral steel. | (115) | Stress varies with percentage of lateral reinforcement. Stress varies with percentage of spiral reinforcement. |

| REQUIREMENTS OF TORONTO BY-LAW | | | REQUIREMENTS OF LONDON BY-LAW |
|---|---|---|---|
| **Formula for Long Columns** | | | |
| (110 Sub 4) | An approved formula to be used where L is greater than 15 times the effective diameter. | (122) | Table given for virtual length greater than 45 times the radius of gyration. |
| **Protection for Columns** | | | |
| (111 Sub a) | 2″ concrete. | (140) | 1½″ and not less than the diameter of rod. |
| **Protection for Beams** | | | |
| (111 Sub b) | 1½″ for beams, 2″ for girders. | (141) | 1″ and not less than diameter of bar. |
| **Protection for Slabs** | | | |
| (111 Sub c) | Not less than 1″. | (142) | ½″ and not less than diameter of bar. |
| **Sleeve Joints** | | | |
| (110 Sub 11) | Rigid where area of rod is greater than 1¼ square inches and ends of rods to be milled. | | Not mentioned. |
| **Dowels** | | | |
| (110 Sub 13) | Required to transfer load to footings. | | Not mentioned. |

# Three-Day Convention of Engineers at Saskatoon

## Engineering Institute of Canada Holds Second General Professional Meeting—Report of Proceedings

SASKATOON, Sask., August 10th.—H. H. Vaughan, of Montreal, president of the Engineering Institute of Canada, presided at the first session (Thursday afternoon, August 8th) of the second general professional meeting of the Institute, held this week in Saskatoon. The first general meeting was held recently in Toronto.

Forty-six members from outside of Saskatoon registered at the session, of whom six were from east of Winnipeg and one from west of Calgary, most of the members present being from Alberta, Saskatchewan and Manitoba. A. G. Dalzell, assistant city engineer of Vancouver, represented British Columbia at the meeting, while the East was represented by the following members:—

H. H. Vaughan, president, Montreal; Fraser S. Keith, secretary, Montreal; James White, councillor, Ottawa; R. F. Uniacke, councillor, Ottawa; R. A. Ross, councillor, Montreal; and H. S. Van Scoyoc, publicity manager, Canada Cement Co., Limited, Montreal.

### Winnipeg and Regina Well Represented

Winnipeg was represented by thirteen members, Regina by eleven, Calgary by eight, Moose Jaw by four, and Edmonton by three.

There were also three visitors at the meeting: Prof. Duff A. Abrams, of Chicago; D. B. Dowling, of Ottawa, president of the Canadian Mining Institute; and G. M. Williams, of the U.S. Bureau of Standards, Washington, D.C.

The first session was devoted exclusively to roads, their location, construction, maintenance and methods of financing, supplemented by papers by the engineers and deputy ministers of highways of the three prairie provinces dealing with their policy in connection with road development. A resolution was passed appointing a committee with a representative from each province to investigate and draw up a standard specification for earth roads for the rural communities and to bring in a report for the next western professional meeting.

### Profession Needs National Society

In opening the convention, President H. H. Vaughan told how he and the executive of the Institute had incorporated into their by-laws the idea of holding professional meetings in various sections of the country. The west should have an equal chance with the east. Another meeting will be held in the fall at Halifax. "We cannot have a first-rate profession," said President Vaughan, "unless we have a good, strong national society to help it out. There is the personal factor in these meetings which cannot be put into books or periodicals. We are constantly asked about the suitability of a certain engineer for a certain position, and we cannot recommend unless we have been in actual personal and professional contact with our men."

Dr. Walter C. Murray, president of the University of Saskatchewan, welcomed the engineers to Saskatoon. "This university," he said, "is the youngest in the west, and on that account I am not inclined to say much. We have arts, law, pharmacy and mechanical engineering schools. We attempted a course in civil engineering, but when the war broke out the two teachers enlisted, one going overseas.

"A distinguished personage from overseas recently conveyed to me his impressions of the enormous waste everywhere in Europe during recent years on account of things that have been lost or have gone astray. I understand that more recently salvage corps organized to prevent waste and to repair have remedied the situation to a large extent. Waste and destruction have always been most characteristic of war.

"There is also extravagance in Canada, as our eastern friends are wont to tell us of the west. With every ton of coal mined and shipped there is a waste of ½ to 1½ tons. For every gallon of gasoline used there is a waste of one-tenth of a gallon, and for every foot of timber used there are three feet lost in manufacture.

"To-day we speak of waste in terms of billions. As regards human life, the wastage of war appals and horrifies. Had such a war occurred seventy years ago there would never have existed a Gladstone, Darwin, Tennyson, Browning or Helmholtz. Talent and ability are going down to nonentity at every charge of our soldiers. Engineers have that trained talent and habits that will enable the people to eliminate waste in many departments. Utilizing waste products is just as possible as utilizing the Latin of our schools."

H. R. MacKenzie, chief field engineer, highways department, province of Saskatchewan, spoke on the location, construction and maintenance of earth roads, presenting data similar to that contained in his article in the June 27th, 1918, issue of *The Canadian Engineer*.

M. A. Lyons, chief engineer, Good Roads Board of the province of Manitoba, dealt with Manitoba's experience. An act of 1914 provided for the borrowing of $2,500,000 for the construction of main market roads and provincial highways. One-third the cost of earth roads and one-half the cost of gravel roads where these are main market roadways, and two-thirds the cost of provincial highways, is defrayed by the government. One-half the cost of permanent bridges of concrete, masonry or steel is advanced and one-third the cost of wooden structures is defrayed by the province.

### Manitoba's Road Experiences

Gumbo roads require at least 12 inches of gravel. Clay is put on the sandy roads which would be impassable in the summer and a couple of inches of sand is put on as a top dressing. Where gravel is very scarce straw is spread on the road and a thin layer of gravel put over it. Manitoba's ordinary market roads are always at least 18 feet wide. The province pays $325 per mile per season on all market roads which are maintained in proper repair throughout the season. The government spent, in all, $680,000 under the Good Roads Act up till the end of 1917.

J. D. Robertson, engineer of highways, Department of Public Works, Alberta, gave the experience of his province. Their first object is to keep the water off; and second, to keep the road when once constructed, maintained.

Care should be taken to have the culverts large enough. If a culvert is so small that it becomes completely full with the first thaw, it is very likely to freeze solid, with the result that it will be full of ice just when it is most needed to prevent the flow of melting snow from cutting away the grade.

Draining sloughs is a difficult problem, because it often necessitates putting a ditch through a grain field, and, almost without exception, it is rather difficult to convince a farmer that the benefits of having a good road will offset any damage to his field. He naturally believes that it would do less damage to his neighbor if it were carried in the opposite direction.

W. H. Greene, assistant city engineer of Moose Jaw, and H. S. Carpenter, deputy minister of highways for Saskatchewan, presented papers on methods of financing roads. (See page 159 for Mr. Greene's paper and next issue for Mr. Carpenter's.)

A committee consisting of H. S. Carpenter, deputy minister of highways, Regina; M. A. Lyons, chief engineer of the Good Roads Board of Manitoba; and J. D. Robertson, chief engineer of the Alberta Highways Department, was appointed to report to the next western meeting of the Institute on the construction and maintenance of earth roads in the prairie province, the road materials available, and a policy of highway construction.

This appointment followed a long discussion on the question of mixing sand with clay or loam, it being asserted that by giving the matter careful attention, results of great value could be attained. It was the consensus of opinion that for many years to come most of the roads in the prairie provinces will be earth roads, and for that reason their proper construction is a problem of vital importance.

### Water Supply and Sanitation

Thursday evening was devoted to water supply and sanitation. E. L. Miles, inspecting engineer, department of irrigation, Calgary, presented a paper. (See page 161 of this issue.)

Geo. D. Mackie, city commissioner of Moose Jaw, called attention to a large section of Saskatchewan, 5,000 square miles in all, far south of the South Saskatchewan River and north of the Shaunavon-Weyburn Railway, where the procuring of good water is practically an impossibility. The war would soon be over and land for returning veterans is being sought, and in order that this land may be properly developed and may furnish subsistence for the large population which should ultimately dwell on it, as well as supply its surplus for the needs of the Empire, an abundant supply of water is most essential. The cost of getting water from the South Saskatchewan would be $5,000,000 or more.

### Concrete

"Concrete" was the subject of discussion for the Friday morning session. A paper by B. S. McKenzie, of Winnipeg, was read by H. M. Thompson, chemist, of Winnipeg. F. C. Field's paper on Alberta's experiences with concrete was read by A. S. Dawson, of Calgary.

Prof. Duff A. Adams, of Chicago, explained how the study of concrete had been carried on at his institute during the last four years. Recently their programme had been disorganized on account of so many engineers having enlisted for service in France. He showed by diagrammatic tables how the strength of concrete depends on the amount of cement in the mixture, the proper proportion of water and the fineness modulus of the aggregate. Manufacturers of sewer pipe are apt to use too little and those of massed work, too much water.

W. G. Chace, engineer of the Winnipeg Water District, spoke of sewer construction in winter in order to relieve unemployment conditions as unsatisfactory. Best conditions for setting require a temperature of 45 degrees.

H. McIvor Weir, assistant city engineer of Saskatoon, pointed out in his paper that the main business section of Saskatoon is built on an alkali slough. Deterioration of sewer manholes built in 1906-7 was first noted in 1910, and these manholes had to be renewed in the alkali localities, whereas those built in ground free of alkali are still in service and in good condition. Mr. Weir also cited several cases of deterioration in the foundations of down-town stores and dwellings. He concluded that proper drainage helps to preserve concrete in alkaline soils, and that waterproofing with pitch or tar does not always prevent alkaline action on concrete.

### Fuel

On Friday afternoon, James White, of Ottawa, dealt with coal, natural gas, petroleum, electricity, peat and wood as the fuels of Western Canada. Coal is much the most important fuel, there being 781 billions of tons beneath the soil of Canada, Alberta having 87 per cent. and Saskatchewan about 6 per cent. of this reserve. Last year the prairie provinces and British Columbia used 2,000,000 tons bituminous and 500,000 of anthracite coal. Lignite forms 93 per cent. of our coal reserve. Our chief problem is to learn to use this lignite to the best advantage.

E. J. Stone, assistant secretary of the Canadian Railway War Board, spoke on the coal situation.

E. C. Hanson, former city electrical engineer of Saskatoon, spoke on his experiences with the combustion of lignites. Mr. Hanson rebuilt the boilers in the Saskatoon power-house, and originated the successful scheme for using Drumheller slack.

Prof. R. D. MacLaurin, of the University of Saskatchewan, gave a short address on the possibilities of straw gas as fuel.

A report of a sub-committee of the Honorary Advisory Council for Scientific and Industrial Research on the briquetting of lignites and the plans for the proposed plant at Estevan, Sask., which the Dominion government is to erect at a cost of $400,000, was read by R. A. Ross.

### Canadian Societies for Canada

The city council of Saskatoon tendered a banquet to the visitors on Friday evening. The toasts were:—

"The King," by Mayor Young; "The Army and Navy," by Dr. Murray and F. H. Peters, of Calgary; "The Allies," by Alderman Galloway and W. M. Scott, of Winnipeg; "Our Guests," by Alderman Lynd, with response by G. D. Mackie, of Moose Jaw; "The Ladies," by Mr. Underwood and J. N. de Stein, of Regina.

President Vaughan spoke briefly, outlining the differences between the engineering and other professions, and predicting the future of the engineering profession. "It is an augury of Saskatoon's future," said Mr. Vaughan, "to note that the Institution of Civil Engineers was inaugurated in London in 1818, while the first professional meeting of the Engineering Institute of Canada is now being held in Saskatoon in 1918. The one, the greatest city of the past; the other, the greatest city of the future."

Mr. Vaughan then emphasized the necessity of Canadian engineers joining Canadian societies and helping to make them strong. If they do not like the way the societies are being run, it is their duty to get in and help to run them. He does not want branches of American societies here. He is not antagonistic to American societies—he is a member of one himself,—but in Canada there should be Canadian societies.

### Legislation

The program for Saturday morning, August 10th, includes papers by F. H. Peters, of Calgary, on "Legislation Governing the Status of Engineers," and "Co-Operation with the Canadian Mining Institute," and also other papers on legislation by C. P. Richard, W. F. Brereton and W. M. Edwards. The meeting will conclude with an excursion Saturday afternoon to various points of engineering interest in and near Saskatoon.

## CORROSION OF IRONWORK

In a paper read before the Iron and Steel Institute, J. N. Friend summarized as follows the results of his researches on the usefulness of paint for protecting ironwork from atmospheric corrosion:—

(1) The practical value of acceleration tests is very small in the present state of our knowledge. Reliable results can only be obtained from tests carried out under conditions closely resembling those prevailing in practice.

(2) Addition of pigment paint to oil increases the efficiency of the latter as a protective paint until a maximum is reached. After this, further addition of pigment causes deterioration. The best results are obtainable from paints possessing as high a percentage of good oil as is compatible with good body and any other working property that has to be considered.

(3) Linseed oil on setting expands by some 3.3 per cent. This is the primary cause of crinkling. Further oxidation causes a decrease in volume, which in time leads to cracking.

(4) Linoxyn is permeable to moisture. The permeability is reduced by heating in absence of air, the oil increasing in density, viscosity, and molecular weight.

(5) Polymerized linseed oil affords a better protection than raw oil when used as a paint vehicle.

(6) The functions of a pigment are to toughen the film and render it less permeable to water-vapour and oxygen. It also reduces the expansion of the oil on setting, and thus minimizes the tendency to crinkle.

(7) A thick coat of paint protects the underlying metal more efficiently than a thin coat, provided the coat is not so thick that running or crinkling takes place.

(8) The very best results are obtained by multiple coats. Two thin coats are better than one thick one of equal weight.

(9) Thinners enable thin coats of paint to be applied. Turpentine leaves a very slight residue behind upon evaporation, but its effect on the efficiency of the paint is small.

(10) Other things being equal, the most permanent paints are those containing black or red pigments, since these absorb the shorter rays of light, and prevent them from hastening the destructive oxidation of the linoxyn by the air.

(11) Finer pigments afford more efficient protection than coarse pigments, since they are more thoroughly in contact with the oil.

(12) Iron structures should be painted whilst their scale is still on, after loosely adherent flakes and rust have been scraped off. The paint will last rather longer than if applied to the pickled or sand-blasted surface, and the labor of removing the scale is saved.

(13) Experiments with rusty plates are not conclusive, but suggest that the rust need not be so carefully removed, prior to painting, as is usually thought to be necessary.

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Four engineers have applied to the city council of Victoria, B.C., for appointment as city engineer to succeed C. H. Rust, resigned.

The power factor of an alternating-current circuit may be defined as the ratio of the actual energy in kilowatts to the apparent energy in kilovolt-ampères, expressed in percentage. For example, if the kilowatt load on a circuit is 1,000 and the kilovolt-ampère load 1,250, then the power factor of the circuit is $1,000 \div 1,250 = 0.80$, or 80 per cent. This relation between actual and apparent energy is dependent on the relative "phase" position, with respect to time, of the current and voltage of the circuit, which in turn is fixed by the characteristics of the circuit and the connected apparatus.

## THE TRAINING OF ENGINEERS

By E. J. Silcock, M.Inst.C.E., F.G.S.

*(Continued from last week's issue)*

E. WILLIS (Chiswick) said he had been much interested in Mr. Silcock's paper. For many years he had been watching the tendency to vary the present training given to young engineers. He thought it a most fortunate thing that they had had Mr. Silcock's paper, so that the Joint Status Committee, which was now sitting in connection with the subject should have the advantage of any opinions that might be expressed in discussion. He had had the privilege of being a member of the Joint Status Committee to consider the training and conditions affecting municipal engineers and surveyors. They had had nearly thirty meetings, and they had tabulated and brought the details that were so important to be considered before the members of the Institution of Municipal and County Engineers in a concrete form, and the Joint Status Committee that had been formed to deal with water engineers should have an equally good, if not a better result. They had had a voluntary examination in the Institution of Municipal and County Engineers for more than thirty years, and over 2,000 students had voluntarily presented themselves. If the Institution of Water Engineers could arrange for a somewhat similar procedure, he thought they might start the ball rolling in a most efficient manner; but with regard to *viva voce* examinations he thought they needed something more immediately practical. They had had a *viva voce* examination for several years, but it was only within the last two years that they had instituted an immediately practical examination, devoting the whole of the day to it, and he was afraid it had shown the weakness of the students very forcibly. He hoped that in any scheme which they drew up the practical element would largely predominate. He was very pleased to hear Mr. Head refer to the importance of engineers being sportsmen; but he did not quite agree with him in his fear that the average boy would break down or become a milksop if he had to undergo the education suggested by the author of the paper. He totally disagreed with Mr. Silcock when he suggested that no attempt should be made to teach mechanical drawing to a boy of seventeen. He (Mr. Willis) thought that to teach a boy mechanical drawing was to give him a rest from mathematical and other dry subjects, and enable him to take more real enjoyment in his work. There was the question of surveying and levelling being better taught after leaving the university. To that extent he was with Mr. Silcock, but he did not quite agree with him in regard to his other remarks as to outside training. He rather thought that short practical courses were eminently beneficial, because in that way a pupil would get more refinement of detail than he would in an office. He was not quite sure whether a university training first was the right training for every boy. He had come across men who were now drawing big salaries who had started their pupilage straight from London public schools. In one case a man went straight from school into the office of an engineer, took his three years' training, and then took a year's course at the university. He worked hard while he was there, and ever since he had been jumping up and up in his profession. It was possible that that training on the sandwich principle, which was being considered in mechanical engineering, might be useful in water engineering. He did not know whether it was so, but it was a point worth consideration. He was especially pleased to notice Mr. Silcock's suggestion that the young student, when in an office, should accumulate a collection of reports and specifications, tenders, and bill of quantities.

C. T. Walrond (Westminster) said that as a member of the Status Committee he considered the paper a very valuable one. Mr. Silcock had given them many useful hints which they could adopt in the training of an engineer, and so tend to improve the status of the profession in the future.

Prof. A. H. Jameson (King's College) said that at his college, where he was an engineering teacher, they made mechanical engineering the foundation for both civil and electrical engineering, and he thought Mr. Silcock was making a mistake in suggesting that mechanical subjects should be excluded from his curriculum. Civil engineering had to do with machinery, and he believed that the Institution of Civil Engineers specified that a young engineer should spend at least one year in mechanical works before embarking on his life's work. He thought that was sound policy, and at King's College they encouraged students to go to mechanical works in their long vacations, and many of them did so, with great advantage to their education. He would like to ask Mr. Silcock why he was so keen to reduce the college course by one year. In his (Prof. Jameson's) opinion three years was little enough, considering they were dealing with boys. In America they extended the course to four years, and he thought they should think twice before they reduced it to two years here; if they did, he believed it would do more harm they good in the long run. As regarded the teaching of drawing and practical training, it was incredible to him, from his experience, that they should teach boys all these theoretical subjects without giving them some interest in the practical side at the same time. They must give a boy some practical training in illustrative and graded drawing to enable him to realize what he was learning. The course of instruction suggested by Mr. Silcock seemed to him to be a specialist course for civil engineering, as the mechanical subjects were left out except in general terms at the end.

Mr. Silcock: No.

Prof. Jameson said it seemed to him that the right thing to do was first to give the boy a good general education at a public school; at college train him as an engineer, and afterwards, when he left college, he became a civil engineer. They were talking all through as if the boy from the beginning had made up his mind to become a water engineer, but his father might have another view of his future, and the boy's tastes might not run in that direction; his special likings might be for something very different. What he wanted to emphasize was that if they decided too soon upon a boy becoming a water engineer, he might make a bad water engineer. One or two of the speakers had referred to the question of theory v. practice. He thought they would all agree that what was really wanted was theory, plus practice, but it had not yet been decided what the proportions should be. He quite agreed with what Mr. Head had said as to the necessity of cultivating a love of sport among their pupils and giving them something to do in the evenings which would be a thorough relaxation and a change from their lectures.

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Activated sludge, when air-dried, is a dark brown, friable, inoffensive material with a slightly earthy odor like that of decayed leaves. It consists largely of humus, but contains much more nitrogen, phosphoric acid and potash than does ordinary manure.

## CENTRALIZED ACTIVITIES OF U.S. NATIONAL ENGINEERING SOCIETIES

By Alfred D. Flinn
Secretary, United States Engineering Council

***Canadian engineers are seeking stronger organization. Whether to merge all technical societies with the Engineering Institute of Canada, or whether to encourage individualistic organizations for special technical purposes and then leave their common problems to the Joint Committee of Technical Organizations or some similar committee, is one of the questions that to-day actively confronts several technical societies in Canada. Mr. Flinn's recital of United States experience with similar questions is therefore instructive. Some of the activities of the United States engineers cannot be emulated in Canada for lack of funds owing to the smaller number of engineers in this country, but they suggest valuable ideas which may be useful in the better organization which many Canadian engineers believe to be essential if the engineering profession in Canada is to hold its own with medicine, law and politics.—Editor.***

ENGINEERS and engineering assistants in the United States have been variously estimated to number from one hundred thousand to three hundred thousand. In the memberships of the seventeen societies having offices in the Engineering Societies Building, New York City, and the fourteen other technical societies holding meetings in that building regularly, are comprised approximately sixty thousand individuals, scattered all over the country. Of engineering organizations in America there are about four hundred, and of these possibly one hundred merit places on lists of technical societies.

We must plead guilty to being but an imperfectly organized profession; nevertheless, during the past fifteen years, and particularly the last two or three years, notable progress has been made. Fifteen years ago several national technical societies which are rapidly becoming of great importance had not been organized and the branches of the profession which they are developing were literally in their infancy. The automotive and aeronautical engineers are particularly striking examples.

### Sixteen-Story Building

Of the four oldest national societies, commonly recognized as the principal engineering organizations of the United States, the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, only the first-named had a suitable permanent home. In March, 1904, Mr. Andrew Carnegie offered $1,000,000 for the erection of a suitable building in New York City for the use of the national engineering societies and $500,000 for an engineers' club. Three of the societies accepted this generous offer and organized the United Engineering Society which was incorporated under the laws of the State of New York in May, 1904, to hold and administer the real estate and other property of these societies which was to be used jointly. Land for the Engineering Societies Building was purchased by the societies and additional money provided by them for the building. It was first occupied in 1906. In 1916 the American Society of Civil Engineers accepted an invitation, renewed in 1915, to join the first three Founder Societies and become a member of United Engineering Society. To accommodate the civil engineers and provide additional room for other purposes, three stories were added to the building, making it a 16-story building. These new stories were first occupied in October, 1917.

Engineering Societies Building contains not only the offices, reading rooms and committee rooms of the four Founder Societies and offices of thirteen other societies, but also a large auditorium and several halls for meetings, a branch office of the U.S. Bureau of Standards, and the reading room and stack rooms of Engineering Societies Library. The total value of the property administered by the United Engineering Society is nearly $2,500,000, exclusive of endowment funds aggregating more than $300,000.

For many years among thoughtful men of the engineering profession, there has been a growing appreciation of the need for a more comprehensive and effective organization, together with a conviction that notwithstanding the advantages accruing from the creation of separate organizations to meet the needs of important new branches of engineering work, something of great value has been sacrificed to these separations and the relatively small groups which have resulted. Attempts to draw together have been made from time to time.

### Co-operative Efforts

Even before the Founder Societies agreed to live together, they joined in 1902 in honoring a great engineer and industrial leader, a man great for his fine qualities of heart as well as for his masterfulness. In forming the John Fritz Medal Board of Award, the four societies undertook their first continuous united activity. This medal, awarded annually, is now regarded as the highest honor which can be bestowed upon an American engineer. The board is composed of sixteen men, four from each society.

In 1915 another man, widely beloved among engineers, Ambrose Swasey, of Cleveland, Ohio, a man of broad sympathies and far vision, cemented a third bond of union by giving $200,000 as the nucleus of an endowment fund for the Engineering Foundation. On the board of sixteen members, created to perform the work for which the fund was given, all four Founder Societies are equally represented. It is the hope that this fund may be greatly increased as the Foundation undertakes important new lines of work. In 1916, to aid in scientific and engineering preparations for war and to promote the nation's development in the years of peace, the National Research Council was called into being by the government through the National Academy of Sciences. To provide a home and support for this young child of the union of engineers and scientists, Engineering Foundation became its foster mother and nurtured it for a year. The National Research Council is now, by Executive Order, permanently established and is the Department of Science and Research of the Council of National Defense. It has offices in Washington and has been provided with large funds for the important work of many varieties upon which it is engaged for the government, as well as for scientific and industrial research. The Council has branch offices in London and Paris officially connected with the American Embassies. Close relationship is still maintained between the Engineering Foundation and the National Research Council.

### "Engineering Foundation"

Engineering Foundation, co-operating with the National Research Council, has undertaken the promotion of industrial and scientific research. The importance of such research is becoming well understood in these war times when new means for supplying old needs as well as new ones are constantly being sought by manufacturers, the government and the public. It has also been suggested that one or more large engineering research laboratories should be established under the administration of Engineering Foundation where problems in applied science relating to various branches of engineering could be studied with suitable equipment at hand for experimentation.

### Engineering Research Laboratories

Investigations of foreign fields of engineering work is another service which Engineering Foundation might perform by sending properly equipped and carefully selected commissions of engineers to gather information and prepare reports. It has not seemed advisable for Engineering Foundation to undertake detailed experimental investigations, since these belong more properly to the laboratories of the universities, the industries and the governmental departments and the proposed engineering research laboratories. It is believed that the Foundation has under consideration large plans for its future usefulness.

Engineering Council is the form of organization adopted after several others for combining the interests and activities of engineers in non-technical matters had been tried and found insufficient. Joint committee work had been attempted in a few instances, but the creation and operation of such committees had been found slow cumbersome and otherwise unsatisfactory. The time consumed in getting such a committee to work, and limitations put upon its authority were forbidding. A standing joint committee to deal with certain kinds of subjects was tried, but could not meet the need.

Engineering Council is an organization of national technical societies of America, created to provide for consideration of matters of common concern to engineers, as well as those of public welfare in which the profession is interested, in order that united action may be made possible. Council is one of the most important expressions of the new order of things among engineers, and is the product of endeavors to deal with affairs other than those which have been denominated technical. It is Council's aim to represent and to serve professional engineers throughout America and thus to advance the welfare of all mankind.

### "Engineering Council"

Engineering Council's organization meeting was held June 27th, 1917. War with Germany having been declared in April, attempts to aid the government in connection with the war occupied a large place in the early work of the Council. Like many other attempts by organizations and individuals in the first months of hostilities, Council's efforts were not highly successful. Much confusion in Washington and elsewhere, for which engineers must bear their share of responsibility, characterized those early days, but a large measure of order has gradually been brought into management of technical matters connected with the war, and in this process Engineering Council has taken its part. Out of these experiences one conclusion stands forth most clearly, to wit, that if Engineering Council had held its first meeting at least three years earlier, and had meanwhile become thoroughly organized and established in the performance of the functions for which it has been created and had accumulated a reasonably complete classified catalogue of the technical engineers of the country, it could have made anticipatory preparations for the inevitable hostilities and when the administration declared war, could have performed at once services of inestimable value to the government. Engineering Council is continuing its endeavors to help in the effective prosecution of the war, but it is directing more and more attention to its permanent functions and to preparations for the profession's large part in the reconstruction and adjustment to follow the conclusion of peace.

Council conducts its work chiefly through committees and the office of its secretary. Public Affairs Committee reports on matters of public policy and those relating to national, state or local government other than engineering and scientific questions. It has prepared preliminary reports upon water power, patent reform, the licensing of engineers, the relationships of engineering schools to the military service and the draft, and upon numerous other important items. In several cases its preliminary investigations have led to the establishment of permanent committees to deal with specific lines of work.

### "American Engineering Service"

American Engineering Service was one of the first committees appointed, the intention being to have it catalog the engineers of the country with sufficient information about the individuals to be prepared to assist the government in finding engineers for all services, to assist engineers in finding suitable engagements in private as well as governmental work and to supply biographical information for numerous purposes. This committee has available through the co-operation of a number of societies extensive classified lists of technically trained engineers in all parts of the country, from which approximately five thousand names have already been furnished the government and other inquirers, for military and civilian engagements.

From these lists a great many appointments have been made of all ranks, including some of the most important positions in the technical war work. Direct relations are maintained with the War Service Exchange of the War Department, which has been created to handle all personnel needs of the various bureaus of that department. The service is also officially recognized by the Navy Department. Both departments call upon it frequently for assistance not only in finding individuals for specific positions, but for large numbers of men, as for the engineer regiments and the tank corps of the army, and for engineer officers of battle ships, destroyers and sugmarines.

Important service has been rendered also in the aeronautical branch of war work. The service is prepared to supply names of civil, mechanical, electrical, mining, metallurgical, chemical, refrigerating, heating and ventilating and other professional engineers and assistants. It has a small paid office staff for routine work and holds regular weekly meetings to consider special problems and matters of policy. With the co-operation of one or another of the Founder Societies, recruiting of technical men for special assignments has on a number of occasions been carried on in Engineering Societies Building by officers of the army and navy.

### Technical Societies' War Committee

The War Committee of Technical Societies, having eighteen members selected from nine organizations, is engaged upon the examination and stimulation of new inventions and upon kindred work for the government. Many of its assignments are of such confidential nature that they may not be so much as mentioned publicly. Its chairman, Mr. D. W. Brunton, is a member of the Naval Consulting Board and the only civilian member of the Executive Board of the Inventions Section of the army general staff.

Fuel is one of most vital necessaries for war and also for peace industries. As a people, we have been most prodigal in the consumption of our natural fuel resources. The economies which it has become necessary to inculcate are largely engineering problems, for those which will count for most are to be effected in the industrial establishments and the transportation systems of the country. Several months ago, therefore, Engineering Council established a Fuel Conservation Committee to collaborate with the Bureau of Mines and the Fuel Administration on the broad policies of fuel utilization and economy. At the Worcester meeting of the American Society of Mechanical Engineers in June, one of the most largely attended and important sessions was conducted under the direction of the chairman of this committee, Prof. L. P. Breckenridge, and brought forth a collection of about eighty papers and discussions by well-informed men.

### Other Special Committees

Improvements in the practice respecting patents have been proposed both by the U.S. Patent Office authorities and by engineers at large. To aid in this work, Engineering Council has appointed a Patents Committee to investigate reforms in the U.S. patent system and in the use of experts in litigation wherein the validity of patents or other technical matters are involved. It will co-operate with similar committees of the National Research Council and the other technical societies and with the Patent Office.

Believing that occasion might arise for Engineering Council to care for matters of common concern to engineers in uniformed and civilian service of the government in connection with the war, during both war time and the period of reconstruction, a small special committee was appointed to suggest the organization and duties of a Military Aid Committee to be created whenever the demand for such services should become sufficiently definite. A few engineer regiments have associations of relatives and friends in this country looking after their needs. The 11th Engineers (Railway) recruited in New York and vicinity, has such an association, which meets occasionally in Engineering Societies Building to listen to letters from men in the regiment, to distribute information and suggestions about welfare work and to raise funds for such work.

Such an organization is practicable in behalf of a military unit recruited chiefly in one locality. The 27th Engineers is a special regiment recruited from the entire country, having no local affiliations but a strong industrial tie. Engineering and Mining Journal in behalf of the mining industry, organized the Association of the 27th Engineers. This association supplies desired articles upon requisition or recommendation of the officers of the regiment. So far these have been for athletic equipment, musical instruments, tobacco, typewriters and knit goods. The 302nd Engineers also have a "Family Unit." Both the 11th and 302nd Engineers have offices in New York City. Mention should be made in this connection of the Professional Classes War Relief of America, on which the engineering societies are officially represented. The functions of this association are to care for dependents of professional men who have been so deprived of income through the effect of the war as to need assistance for education of children or for maintaining a simple, decent standard of living.

### Water Power Development

Water power development has been receiving active consideration by Congress and the attention of the public because of the shortage of fuel, has been turned more acutely to the possibilities of water power. Engineering Council made a valuable contribution to the discussion of this question through a notable paper presented by Calvert Townley, one of its members, to the Chamber of Commerce, U.S.A., and used by that Chamber in its referendum, sent to all local Chambers of Commerce in the country last winter.

### Water Conservation Committee

But power development is only one phase of the great subject of the utilization of water. To be broadly prepared, Engineering Council has created a Water Conservation Committee, of men well-informed in the several branches of the subject. By this means it is expected that Council will be ready to deal with broad questions of policy which may arise in any part of the country in connection with the utilization and control of water for municipal supply, power development, navigation, irrigation, sewage disposal, flood prevention and other purposes and to promote such consideration of water resources by Concress and legislatures as will result in conservation through wise use rather than unintelligent restriction or appropriation to a narrow use at the expense of some more important use.

Licensing of engineers and architects has been a matter for discussion in the legislatures of a number of states and will be under consideration in one or more states in all probability during the coming fall and winter. In a few states, laws have already been passed. In order to collect and digest information on this subject and to be prepared to assist the engineers of any state in connection with proposed legislation, Engineering Council is organizing a committee carefully selected to secure sufficient geographical representation and to be composed of such men as would give weight and contribute sound opinions to the work of the committee.

Membership on the committees of Engineering Council is not restricted to the representatives on the Council, although usually the chairman or at least one member of the committee is a representative. In the main, the committees are made up of the older members of the profession who have had large experience in the activities of the societies. Reasons for this are obvious. Provision has been made, however, for utilizing the efforts of other men who can give time to these worthy tasks by authorizing and encouraging committees to associate with their members men who can assist them effectively. To advance this feature of the work, the secretary has undertaken to create a list of men who have expressed their readiness to aid whenever called upon.

### Membership Not Restricted

Although Engineering Council was created by the civil, mining, mechanical and electrical societies, it was intended that membership should not be restricted to these organizations. Procedure has therefore been adopted for the admission of other national engineering or national technical societies,—national in the scope of their activities and not by title identified with any state or municipality,—and devoted to the advancement of the engineering arts and sciences. Each additional society will be entitled to name one representative on Engineering Council for each 2,000 members. For each representative it shall pay an entrance fee of $250 and its *pro rata* share of the running expenses of Council based on the total number of representatives.

Engineering Societies Library is the consolidation of the former separate libraries of the Founder Societies augmented by subsequent purchases and gifts. It contains about 130,000 books and pamphlets and is growing constantly. A recent important gift is the library of the

Board of Patent Control of the Westinghouse and General Electric Companies, containing 9,000 carefully selected volumes relating to electrical patents. Engineering Societies Library is the largest and most important technical library in the western hemisphere and probably in the whole world. The ideal which the managers of the Founders Societies had before them, when they combined their individual libraries under the United Engineering Society was to make a library which would contain everything that an engineer would find useful in his work, to eliminate the unnecessary duplication and cost occasioned by separate libraries, and to obviate the necessity of visiting several libraries to collect all the data on a subject. It is believed that the united institution is easier to use, is more efficient and can do its work more cheaply than four independent libraries. It is making every effort to keep abreast of modern developments. While not within sight of its ideal, certain fields are quite thoroughly covered and attention is being directed toward improving the weaker sections.

### Engineering Societies Library

The library offers its collection freely for use of anyone interested. The service given is divided into two classes, depending upon whether the inquirer visits the library or does not. To the visitor the library offers open access to the most important books and periodicals, catalogs of the collection, a comfortable reading room and the general help of trained librarians, who are glad to assist him in finding anything that he desires.

The man who cannot visit the library can still receive help from it. His letter is turned over to a special assistant, who searches for the answer to his question and compiles a list of references to books and articles which seem pertinent. This is mailed to him. In many cases much of the material is available in local libraries. Whenever it is not, Engineering Societies Library will make copies of any or all of the references for him, will translate these in foreign tongues, and will, in fact, attempt any method that it can devise to get the information to him.

For these special personal services it is necessary to charge fees sufficient to cover the cost of the time spent on them. These fees are carefully adjusted to cover only the actual cost of doing the work personally, as the searchers are experienced in this particular task and so go more directly to the information. The present price for searching is $1.50 an hour; for copies, 25 cents a page, and for translations from $3.50 upwards a thousand words. Some 2,200 inquiries have been handled in the three years that this service has been in operation, showing that there is a demand. The fact that many inquiries come from men who could easily visit the library, but who find this more satisfactory, is interesting.

### Dream of Comprehensive Index

Many engineers wish to be informed of new articles on certain topics as they appear in periodicals. The library undertakes to do this, for an annual subscription of $10, by mailing a card for each article on the subject as it appears. This work entails the reading of the magazines as received, the checking of the appropriate articles and the writing of individual cards for the subscribers. It is felt that this service will grow constantly as it becomes more widely known, for it provides a personal index including only relevant matter.

The library, we feel, is only at the beginning. Many ways in which it can be improved are apparent. It hopes to classify and catalog the collection better, to make its collection stronger and to broaden its scope. It hopes to improve its search service, and will do so as the collection increases. It has a dream of the preparation of a really comprehensive index to engineering literature, and the further dream that the publication of this may become possible. It has, in fact, a half a century of work planned.

### Development of Specialized Societies

Its needs are two—more money and more skilled workers. More money means an opportunity to do more things for the benefit of engineers; more skilled workers, the ability to do them better. The war has hit the libraries, as well as other institutions. We find that skilled men have been drawn into other lines, and that competent searchers are hard to get. Until the war is over this shortage of men with sufficient technical training will continue to hamper us, but we shall give the best service that we can and try constantly to improve it. The library desires to be of service in any possible way.

This brief historical review makes apparent really encouraging progress toward such an organization of the engineering profession as will make possible a larger service to the country and more effective mutual helpfulness among the societies and members.

Whether the ultimate goal shall be fusion or further federation of national societies is a matter for discussion. Able advocates are found for both opinions. In the present stage of development at least, the perfecting of the process of federation so well begun, is preferable. There are disadvantages in too large an organization.

Although there are functions which can be accomplished more effectively and economically by co-operation through the centralized organizations created during these past few years, there are other functions which as yet can best be performed by societies each devoting attention to an important, distinct portion of the technical field.

There are, doubtless, too many societies and some of them could with advantage be amalgamated, but beyond a certain degree, it is believed that more good will be accomplished for engineers and the public by developing and perfecting these large national societies which have distinct reasons for their existence.

### General Local Organizations

Experience is demonstrating that a comprehensive organization is the best local type; that is to say, in most localities there are many advantages in having engineers of all branches of the profession connected with one organization. In some places one general society has existed for many years and when local sections or chapters of national societies have been formed, they have been affiliated with the older local organization. In other localities in which separate organizations were established first, it has been found advantageous to unite in creating a club or association. In any scheme provision can be made for general meetings or for civic or other local activities of common interest, while the several branches of national societies can have meetings devoted to their particular specialties.

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The English Channel Tunnel, said Sir Arthur Fell at a recent meeting in London, Eng., will be the earliest and greatest of all the works of peace which will be begun immediately the war is over, and when labor and materials have become available. "It will be the first monument to the new era of peace, and to an enduring friendship with the immortal race which for four years has been fighting by our side for the liberty of the world. This link will unite the two nations in a permanent bond that will enable the two peoples to know each other better, and to appreciate one another more."

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# The Canadian Engineer

Published Weekly. Established 1893.

*Issued in the Interests of Canadian Civil Engineers and Contractors*

The field includes chiefly the men who are engaged in municipal, railroad, hydraulic, structural, highway and consulting engineering; surveying; mine management; contracting; and water works superintendence.

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January 1 to June 30, 1918

Published every Thursday by THE MONETARY TIMES PRINTING CO. OF CANADA, LIMITED
HEAD OFFICE: CORNER CHURCH AND COURT STREETS, TORONTO, ONTARIO
*JAMES J. SALMOND, President and General Manager. ALBERT E. JENNINGS, Assistant General Manager.*
**Telephone Main 7404; Branch Exchange connecting all Departments.**
**Cable Address: "Engineer, Toronto."**
WESTERN CANADA OFFICE: 1208 McArthur Building, Winnipeg. G. W. GOODALL, Western Manager.

# The Canadian Engineer

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## AMERICA'S ENERGY SUPPLY*

By Dr. C. P. Steinmetz
Chief Consulting Engineer, General Electric Co.

THE only two sources of energy which are so plentiful as to come into consideration in supplying our modern industrial civilization, are coal, including oil, natural gas, etc., and water power.

While it would be difficult to estimate the coal consumption directly, it is given fairly closely by the coal production, at least during the last decades, when wood as fuel became negligible; and export and import, besides more or less balancing each other, were small compared with production. Coal has been mined since 1822, and in Fig. 1 is recorded the coal production of the United States, from governmental reports. The annual production is marked by circles, and decennial average by crosses, every five years. Table I. gives the decennial averages in millions of tons per year.

**Table I.—Average Coal Production of the United States**

| Year | Millions Tons per Year | Per cent. Increase per Year |
|---|---|---|
| 1825 | 0.11 | ... |
| 1830 | 0.32 | 22.4 |
| 1835 | 0.83 | 19.7 |
| 1840 | 1.92 | 17.0 |
| 1845 | 4.00 | 14.5 |
| 1850 | 7.46 | 10.45 |
| 1855 | 10.8 | 8.35 |
| 1860 | 16.6 | 8.72 |
| 1865 | 25.9 | 9.22 |
| 1870 | 40.2 | 8.58 |
| 1875 | 56.8 | 7.42 |
| 1880 | 82.2 | 7.95 |
| 1885 | 122 | 6.80 |
| 1890 | 160 | 5.40 |
| 1895 | 206 | 5.75 |
| 1900 | 281 | 6.96 |
| 1905 | 404 | 6.60 |
| 1910 | 532 | ... |

As ordinates, in Fig. 1, are used the logarithms of the coal production in tons. With this scale, a straight line means a constant proportional increase, that is, the same percentage increase per year; and in the third column of Table I. are given the average percentage increases of coal production per year.

Fig. 1 is of extreme interest in that it shows the great irregularity of production from year to year, and at the same time a very great regularity when extending over a long period of time. Since 1870 the average production can well be represented by a straight line, the values lying irregularly above and below the line, which represents an annual increase of 6.35 per cent., and thus the average coal production† $C$ in the equation:

$$C = 45.3 \times 10^{0.0267\,(y-1870)} \text{ million tons}$$

or:

$$\log C = 0.0267\,(y - 1870) + 7.656$$

where

$$y = \text{year.}$$

Before this time, from 1846 to 1884, the coal production could be represented by:

$$C = 7.26 \times 10^{0.0365\,(y-1850)} \text{ million tons}$$

or:

$$\log C = 0.0365\,(y - 1850) + 6.861$$

representing an average annual increase of 8.78 per cent.

It is startling to note how inappreciable, on the rising curve of coal production, is the effect of the most catastrophic political and industrial convulsions, such as the Civil War, and the industrial panic of the early 90's; they are indistinguishable from the constantly recurring annual fluctuations. It means that the curve is the result of economic laws, which are laws of nature.

Extrapolating from the curve of Fig. 1, which is permissible due to its regularity, gives 867 million tons as this year's coal consumption. As it is difficult to get a conception of such an enormous amount, a comparison may illustrate it best: One of the great wonders of the world is the Chinese wall, running across the country for hundreds of miles, by which China unsuccessfully tried to protect its northern frontier against invasion. Using the coal produced in one year as building material, we could with it build a wall like the Chinese wall all around the United States, following the Canadian and Mexican frontiers, the Atlantic, Gulf, and Pacific coasts; and with

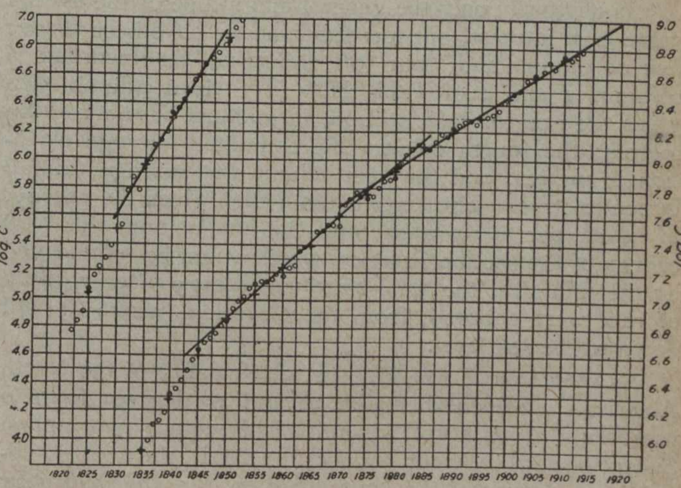


**Fig. 1—Coal Production of the United States**

the chemical energy contained in the next year's coal production, we could lift this entire wall 200 miles high into space. Or, with the coal produced in one year as building material, we could build 400 pyramids larger than the largest pyramid of Egypt.

It is interesting to note that:—

| | |
|---|---|
| One hundred thousand tons of coal were produced in the United States in | 1825 |
| The production reached one million tons in | 1836 |
| It reached ten million tons in | 1852 |
| It reached one hundred million tons in | 1882 |
| It will reach 1,000 million tons about | 1920 |
| And if continuing to increase at the same rate, it will reach 10,000 million tons in | 1958 |

Estimating the chemical energy of the average coal as a little above 7,000 calories, the chemical energy of one ton of coal equals approximately the electrical energy of one kilowatt-year (24-hour service). That is, one ton of coal is approximately equal in potential energy to one kilowatt-year.

Thus, the annual consumption of 867 million tons of coal represents in energy 867 million kilowatt-years.

However, as the average efficiency of conversion of the chemical energy of fuel into electrical energy is probably about 10 per cent., the coal production would be able, if converted into electrical energy, to give about 87 million kilowatts.

Assuming, however, that only one-half of the coal is used for power, at 10 per cent. efficiency, the other half

*Excerpt from a paper presented at the Annual Convention of the A.I.E.E., June, 1918.

†Soft coal and anthracite, and including oil reduced to coal by its fuel value.

as fuel, for metallurgical work, etc., at efficiencies varying from 10 to 80 per cent., with an average efficiency of 40 per cent., we get in electrical measure 217 million kilowatts (24-hour service) as the total utilized energy of our present annual coal production of 867 million tons.

### Potential Water Powers

Without considering the present limitation in the development of water powers, which permits the use of only the largest and most concentrated powers, we may try to conceive the total amount of hydraulic energy which exists in the United States, irrespective of whether means have yet been developed or ever will be developed for its complete utilization. We then proceed from the estimation of the energy of the total rainfall.

Superimposing the map of rainfall in the United States upon the map of elevation, we divide the entire territory into sections by rainfall and elevation. This is done in Table II. for that part of the continent between 30 and 50 degrees northern latitude.

As obviously only the general magnitude of the energy value is of interest, but few subdivisions have been made: five of rainfall and four of elevation, as recorded in columns 1 and 2 of Table II.* The third column then gives the area of each section, in millions of square kilometres; the fourth column the estimated average elevation in metres, and the fifth column the average rainfall in centimetres. The sixth column then gives the energy, in kg-m. per $m^2$ of area; and the last column the total energy of the section in kg-m. which would be represented by the rainfall if the total hydraulic energy of every drop of rain were counted, from the elevation where it fell down to the sea level.

As seen from Table II., the total rainfall of the North American continent between 30 and 50 degrees latitude represents $3,000 \times 10^{15}$ kg-m. This equals 950 million kilowatt-years (24-hour service). That is, the total potential water power of the United States, or the hydraulic energy of the total rainfall, from the elevations where it fell, down to sea level, gives about 1,000 million kilowatts.

However, this is not available, as it would leave no water for agriculture; and, even if the entire country were one hydraulic development, there would be losses by seepage and evaporation.

**Table II.—Total Potential Water Power of the United States**

| Rainfall inches | Elevation feet | Area $\frac{m^2}{10^{12}}$ | Average elevation metres | Average rainfall cm. | $\frac{kg\text{-}m.}{10^3}$ per $m^2$ | Total $\frac{kg\text{-}m.}{10^{15}}$ |
|---|---|---|---|---|---|---|
| < 10 | > 5,000 | 0.54 | 2,100 | 12.5 | 263 | 142 |
| | 1,000-5,000 | 0.29 | 900 | ... | 112 | 32.5 |
| 10-20 | 5,000 | 1.18 | 2,100 | 37.5 | 787 | 930 |
| | 1,000-5,000 | 1.96 | 900 | ... | 338 | 660 |
| 20-30 | 1,000-5,000 | 0.32 | 900 | 62.5 | 563 | 183 |
| | 100-1,000 | 0.97 | 150 | ... | 94 | 91 |
| 30-40 | 1,000-5,000 | 0.35 | 900 | 87.5 | 786 | 275 |
| | 100-1,000 | 1.40 | 150 | ... | 131 | 184 |
| 40-60 | 1,000-5,000 | 0.27 | 900 | 125 | 1,130 | 305 |
| | 100-1,000 | 1.03 | 150 | ... | 188 | 194 |
| | Total | | | | | 2,996 |
| | Approximately | | | | | 3,000 |

An approximate estimate of the maximum potential power of the rainfall, after a minimum allowance for agriculture and for losses, is made in Table III. In this, 12.5 cm. rainfall has been allowed for wastage, and 25 and 37.5 cm. respectively, for agriculture where such is feasible.

*The lowest elevation, < 100 feet is not included, as having little potential energy.

**Table III.—Available Potential Water Power of the United States**

| Average rainfall cm. | Average elevation m | Area $\frac{m^2}{10^{12}}$ | Wastage cm. | Agriculture cm. | Available rainfall cm. | $\frac{kg\text{-}m.}{10^3}$ per $m^2$ | Total $\frac{kg\text{-}m.}{10^{15}}$ |
|---|---|---|---|---|---|---|---|
| 12.5 | 2,100 | 0.54 | 12.5 | ... | ... | ... | ... |
| | 900 | 0.29 | 12.5 | ... | ... | ... | ... |
| 37.5 | 2,100 | 0.39 | 12.5 | 25 | ... | ... | ... |
| | 2,100 | 0.79 | 12.5 | ... | 25 | 525 | 415 |
| | 900 | 0.98 | 12.5 | 25 | ... | ... | ... |
| | 900 | 0.98 | 12.5 | ... | 25 | 225 | 220 |
| 62.5 | 900 | 0.21 | 12.5 | 37.5 | 12.5 | 112 | 23 |
| | 900 | 0.11 | 12.5 | ... | 50 | 450 | 50 |
| | 150 | 0.97 | 12.5 | 37.5 | 12.5 | 19 | 18 |
| 87.5 | 900 | 0.35 | 12.5 | 37.5 | 37.5 | 337 | 118 |
| | 150 | 1.40 | 12.5 | 37.5 | 37.5 | 56 | 78 |
| 125 | 900 | 0.27 | 12.5 | 37.5 | 75 | 674 | 182 |
| | 150 | 1.03 | 12.5 | 37.5 | 75 | 112 | 116 |
| Total | | | | | | | 1,220 |

This gives as total available potential energy about $1,200 \times 10^{15}$ kg-m., or 380 million kilowatts (24-hour service).

Assuming now an efficiency of 60 per cent. from the stream to the distribution centres, there remain 230 million kilowatts (24-hour service) as the maximum possible hydro-electric power which could be produced if, during all seasons, every river, stream, brook, or little creek throughout its entire length from the spring to the ocean, together with all the waters of the freshets, could be and were used. It would mean that there would be no running water in this country; in fact, there would be only stagnant pools connected by pipe lines to turbines exhausting into the next lower pool. Obviously, we could never reasonably hope to develop more than a part of this power.

### Discussion

It is interesting to note that the maximum possible hydraulic energy of 230 million kilowatts is little more than the total energy which we now produce from coal, and is about equal to the present total energy consumption of the country, including *all* forms of energy.

This is rather startling. It means that the hope that when coal once begins to fail we may use the water powers of the country as source of energy is and must remain a dream; for if to-day all the potential water power of the country were developed and every rain drop used it would not supply our present energy demand.

Thus hydraulic power may and should supplement coal as a source of power, but can never replace it.

This probably is the strongest argument for efforts to increase the efficiency of our means of using coal.

The source of energy, which is practically unlimited, if it only could be used, is solar radiation. Estimating the solar radiation at the earth surface as 1.4 calories per sq. cm. per minute would give, per sq. cm. horizontal surface between latitudes 30 and 50, assuming 50 per cent. cloudiness, an average throughout the year (24 hours per day) of about 0.14 calories per sq. cm. horizontal surface per minute and on the total area of North America, between 30 and 50 latitude, 8.3 million square kilometres, a total of approximately 800,000 million kilowatts (24-hour service)—a thousand times as much as the total chemical energy of our coal consumption, or 800 times as much as the potential energy of the total rainfall.

Considering that the potential energy of the rainfall—from surface level to sea level—is a small part of the potential energy spent by solar radiation in raising the rain to the clouds, and that this is a small part of the total solar radiation, the foregoing is reasonable.

Considering only the 2.7 million square kilometres of Table III., which are assumed as unsuited for agriculture, and assuming that in some future time and by inventions not yet made, half of the solar radiation could be collected, this would give an energy production of 130,000 million kilowatts.

Thus, even if only one-tenth, or 13,000 million kilowatts, of this could be realized, it would be many times larger than all the energy of coal and water power. Here, then, would be the great source of energy for the future.

### Hydro-Electric Stations

In developing the country's water powers, thus far only those of greatest energy concentration have been considered, that is, those where a large volume and a considerable head of water were available within a short distance.

This led, as the best solution for the problem, to the present type of hydro-electric generating station, comprising: Three-phase synchronous generators, directly connected to hydraulic turbines of the highest possible efficiency; speed-governing mechanism for hydraulic turbines; an exciter plant comprising either exciters directly connected to the generators or several separate exciters connected to separate turbines; exciter busbars; voltmeter, and ammeters in exciter armature and alternator field circuits; field rheostats for the alternators; low-tension busbars, either in duplicate or with transfer or synchronizing bus; circuit breakers between generators and busbars, usually non-automatic; circuit breakers between transformers and busbars, usually automatic, with time limit; voltmeters and potential transformers at the generators supplying synchroscopes or other synchronizing devices, ammeters and current transformers at the generators, voltmeter and potential transformer at the busbar, ammeters and current transformers at the step-up transformers, totaling ammeter for the station output, integrating wattmeter, relays, interlocking devices, etc., etc., step-up transformers, high-tension busbars (possibly in duplicate), high-tension circuit breakers between transformers and high-tension busbars, high-tension circuit breakers between high-tension busbars and lines, lightning arresters in the transmission lines, with inductances, etc., ground detectors, arcing-ground or short-circuit suppressors, voltage indicators, etc., automatic recording devices (multi-recorder), rarely used, though very desirable.

It will be seen that, due to the high powers controlled by modern stations, the auxiliary and controlling devices in these stations have become so numerous as to make the station a complex structure requiring high operating skill and involving high cost of installation.

Not only are all these devices necessary for the safe operation of the station, but at the same time it must be expected that, with the further increase of power of our electric systems, additional devices will become necessary for safe and reliable operation. One such device I have already mentioned, *viz.*, the automatic recording apparatus, such as the multi-recorder.

With this type of station it obviously is not possible, in most cases, to develop water powers of small and moderate size, and a generating station of a thousand horse-power will rarely, or one of a hundred horse-power hardly ever, be economical.

On the other hand, a hundred horse-power motor installation is a good economical proposition, and the average size of all the motor installations is probably materially below one-hundred horse-power.

Looking over Table II., and especially Table III. on the preceding page, it is startling to see how large a part of the potential water power of the country is represented by relatively small areas of high elevation, in spite of the relatively low rainfall of these areas. As most of these areas are at considerable distances from the ocean, most of the streams are small in volume. That is, it is the many thousands of small mountain streams and creeks, of relatively small volume of flow but with high gradients affording fair heads, which apparently make up the bulk of the country's potential water power.

Only a small part of the country's hydraulic energy is found so concentrated locally as to make its development economically feasible with the present type of generating station. Therefore, some different and very much simpler type of generating station must be evolved before we can attempt to economically develop these many thousands of small hydraulic powers, and collect the power of the mountain streams and creeks.

### Simplification of Hydro-Electric Station

The following discussion of the simplification of the hydro-electric station to adapt it to the utilization of smaller powers is limited to the case where smaller hydraulic stations feed into a system containing some large hydraulic or steam-turbine stations from which the system may be controlled.

We may eliminate the low-tension busbars, with generator circuit breakers and transformer low-tension circuit breakers, and connect each generator directly to its corresponding transformer, making one unit of generator and transformer, and do the switching on high-tension busbars which, with the circuit breakers, can be located outdoors. While it is dangerous to transformers to perform the switching on the high-tension side, due to the possibility of cumulative oscillations, this danger is reduced by the permanent connection of the transformer to the generator circuit, and is less with the smaller units used in small power stations, and therefore permissible in this case. However, the simplification effected is pronounced, since ammeters, voltmeter and synchronizing devices with their transformers are still retained on the low-tension circuits.

Since it is not economical to operate at partial load, proper operation of a hydraulic station on a general system requires that as many units operate fully loaded as there is water available for, and to increase or reduce the number of units (of turbine, generator and transformer, permanently joined together) with the changing amount of available water, thus using all the energy of which the water is capable.

In this case the turbine governors, with their more or less complex hydraulic machinery, may be omitted. If, then, the generators are suddenly shut down by a short circuit which opens the circuit breakers, the turbines will race (run up to their free running speed) until the gates are shut by hand. However, generators and turbines must be able to stand this, as even by the use of governors the turbines may momentarily run up to their free speed, in case of a sudden opening of the load, before the governors can cut off the water. Where this is not desirable, some simple excess speed cut-off may be used.

When eliminating the governing of the turbine and running continuously at full load, the question may be raised whether generator ammeters are necessary, as the load is constant and is all the power that the water can give. With synchronous generators, however, the current depends not only on the load, but also on the power-factor of the load, and with excessively low power-factor due to wrong excitation the generators may be overheated by excess current, while the power load is well within their capacity. Thus ammeters are necessary with synchronous generators. As soon, however, as we drop the use of synchronous generators and adopt induction generators, the ammeters with their current transformers may be omitted, since the current and its power-factor are definitely fixed by the load. At the same time, synchronizing devices, together with potential transformers, generator voltmeters, etc., become unnecessary. A station voltmeter may be retained for general information but is not necessary, as the voltage and frequency of the induction generator station are fixed by the controlling synchronous main station of the system.

With the adoption of the induction generator the entire exciter plant is eliminated, as the induction generator is excited by lagging currents received from synchronous machines, transmission lines, and cables existing in the system. Thus are dispensed with the exciters, exciter buses, ammeters, voltmeters, alternator field rheostats, etc.; in short, most of the auxiliaries of the present synchronous station become unnecessary.

Thus, the solution of the problem of the economic development of smaller water powers is found in the adoption of the induction generator.

Stripped of all unnecessaries, the smaller hydro-electric station would comprise: Hydraulic turbines of simplest form, continuously operating at full load, without governors; low-voltage induction generators directly connected to the turbines; step-up transformers directly connected to the induction generators; high-tension circuit breakers connecting the step-up transformers to the transmission line (In smaller stations, even these may be dispensed with and replaced by disconnecting switches and fuses); lightning arrester on the transmission line, where the climatic or topographical location makes these necessary; a station voltmeter, a totaling ammeter or integrating wattmeter and a frequency indicator may be added for the information of the station attendant, but are not necessary, as voltage, current, output, and frequency are not controlled from the induction generator station, but from the main station, or are determined by the available water supply.

It is interesting to compare this induction generator station lay-out with that of the modern synchronous station before mentioned. However, it must not be forgotten that the simplicity of the induction generator station results from the transference of all the functions of excitation, regulation, and control to the main synchronous stations of the system, and thus the induction generator stations are feasible only as adjuncts to at least one large synchronous station (hydraulic or steam turbine) in the system, but can never replace the present synchronous generator stations in their present field of application.

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A German municipal factory is using tar successfully in place of tar oil as a fuel for Diesel engines driving centrifugal waterworks pumps delivering 1,100 to 1,200 cubic metres per hour against a head of 12.5 m. The method is to heat the tar to 30 or 35 deg. Cent. by the circulating water, and then pass it slowly under a head of 4 m. through a bed of gravel about 16-in. thick. The size of the gravel particles is from 1 to 1.5 mm. The filter is placed high up and the tar flowing from it is heated by exhaust gases, so that it reaches the fuel pumps at 70 to 80 deg. Cent. The filter works without attention for about four weeks, and complete combustion is obtained in the working cylinders.

## THE SHELL OF THE LONG-RANGE GUN WHICH BOMBARDED PARIS

NOTHING definite has yet been discovered as to the nature of the German long-range gun nor of the shell it fires. Nicholas Flamel, in an article in a recent number of "Le Genie Civil," puts forward some plausible hypotheses, based on the known facts, *viz.*: the fragments of burst shell; the white smoke which nearly always accompanies the burst; that the splinters show no traces of adhering explosive; and the use of the diaphragm with its special fittings, the exact function of which is still inexplicable.

After considering the various recognized explosives and rejecting them for one reason or another, M. Flamel suggests that the Germans may have used the following method, in which case the diaphragm would fulfil a different function from that which he previously attributed to it. In order that the shell should leave a white smoke on bursting, which is desirable for registering purposes, but no trace of explosive on the metal of the shell, he believes it possible the Germans may use an explosive of the panclastite or hellhoffite type which would burst on impact without a fuse being necessary.

The diaphragm and auxiliary parts, the function of which is still obscure, would be used to divide the shell chamber into two parts, which would be in communication with each other only on the gun being fired. The impact on discharge would open a communicating channel and allow the more dense liquid to flow into the rear chamber while the shell was travelling along the ascending part of the trajectory. Rotation of the shell would give the mixture time to be thoroughly incorporated by the time the shell had arrived at the end of its flight, since the time of flight is three minutes. An explosive of this kind would be safe on the gun being fired, since the explosive mixture is not formed until the shell has left the gun. It would also be certain to act when the object was struck, because it has been shown with certain panclastites of the carbon disulphide type that it is impossible to fire them from a gun, even at low muzzle velocities, without their detonating.—The Engineer, London, Eng.

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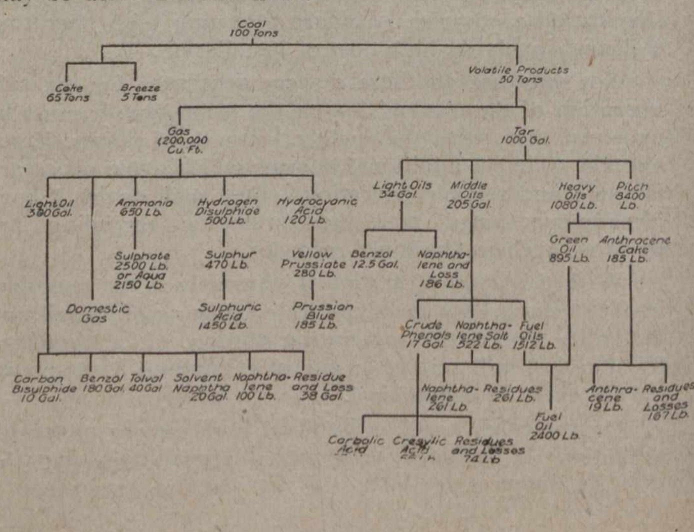
## BY-PRODUCTS OF COAL

IN a recent issue of the General Electric Review appeared the following chart showing the by-products resulting from the distillation of 100 tons of coal in the manufacture of coke, and the various substances that may be derived from them:—



## METHODS OF FINANCING FOR GOOD ROADS*

By W. H. Greene,
Assistant City Engineer, Moose Jaw, Sask.

THE primary requisite for good roads is money, and this money must be furnished by the people through some form of taxation. Just how this taxation shall be levied and apportioned so that the burden will fall equally on each citizen without causing undue hardship is the problem which confronts this province of Saskatchewan in common with the rest of Canada and the United States. In the early days in Canada, when the need for roads was first felt, the first system of finance was by statute labor, and when first promulgated was so just a solution that no one even thought of objecting to it as placing an unjust burden on them. The roads constructed served their purpose until the increase in traffic made a more expensive type necessary, one that was not merely a fair weather road for light traffic, but one that could be used for heavy traffic conditions regardless of the weather. This necessitated the adoption of a new system for raising the funds required to construct them, and the example of the cities whereby the abutting property was taxed to provide the funds was followed. When adopted this was a reasonably equitable solution of the problem, and was quite satisfactory as long as the property owners who paid the taxes obtained the major benefit from the improvement. During the last decade the growth of automobile traffic has changed the situation, for now the majority of the users of the highways are not abutting property owners, and have, therefore, contributed nothing towards the cost of constructing or maintaining the improvement which they enjoy. It will be accepted as a general principle that the cost of public improvements should be borne by the public in proportion to the benefit received, and to conform to this the majority of the methods of finance in use at present require readjusting.

This problem of finance divides itself readily into:—

(1) In what manner the funds will be made available for the actual work of construction.

(2) Who will ultimately pay for the improvement.

### Bond Issue is Popular

The funds for construction purposes can be raised in several ways, viz., by the issuing of bonds; by so arranging or curtailing the year's work that its cost will fall within the annual road appropriation; or by "hoarding" the annual appropriation until a sufficient sum has been collected to enable an economically large and connected programme to be undertaken and carried to completion.

Each method has its advocates, but the bond issue is the most popular. The issuance of highways bonds is essentially a method of capitalizing the resources of a community for the purpose of creating improved highways. The fundamental advantage of the bond plan is the construction of a good system of roads at once, but there are secondary advantages in building roads in long stretches and in the planning of the maintenance of such roads.

### Maximum Economic Efficiency

The question is not merely whether a community shall incur a debt; it is also a question as to whether the maximum economic efficiency and the full development of the public wealth will be best promoted by using public credit. Highway improvement with borrowed money must be regarded as an investment. The only way, however, that a measurable income arises from the investment is by the reduction of hauling costs. From the standpoint of public economy the annual cost of hauling represents the operating expenses of the road system. The direct return upon the highway investment, then, is the reduction in operating expenses. This difference between the old hauling costs and the hauling costs over the improved roads is a real saving to the community. There are many additional economic benefits and very great social benefits which are not readily measured, such as increased school and church attendance, improved social intercourse and usually an added stimulus to business.

### Improves Rural Property

The very presence of the improved road system increases the value of the rural property, and, therefore, the resources supporting the loan. It is a well-established business principle that extension of credit within safe limits is necessary for maxmum results.

However, care must be exercised as to the term of the bonds and the type of construction financed in this manner. Here we can profit by the mistakes made elsewhere. In issuing bonds they should mature within the life of the improvement, thus insuring the taxpayer value for money expended, but should not mature before this time, or else the present users will be paying for something which future users will enjoy at no cost except for maintenance.

### Term of the Bond

Many highway officials affirm that the term of the bond need not be equal to or less than the life of the improvement, provided that the cost if maintenance and renewals is paid for out of current funds, and cite the case of railroads as an example. They claim that railroad ties only last about ten years, and rails have an average life of about twenty years, but that railway bonds usually have a life of fifty years—and then are refunded with other long-term bonds.

### Enduring and Perishable Features

The cost of highway construction may be subdivided into (*a*) cost of enduring features, and (*b*) cost of perishable features. Grade, alignment, drainage structures and foundations, if built to conform to a set standard, can be classed as enduring structures, and can safely be financed by a bond issue. The wearing surface, which is the perishable feature, can also be safely financed in the same way, provided ample provision is made for maintenance, and if adequately maintained this wearing surface will protect the enduring features in the investment, and the issue can be set to mature at a later date. Inadequate provision for maintenance is the gravest defect in the practice of building roads with borrowed capital. The bonds may be of the sinking fund, annuity or serial form, the latter being the most commonly used in the States, as the capitalists favor it as making the investment safer. With this form there is never the necessity to issue refunding bonds at the end of the term. This form also saves the community more money than with the sinking fund type, as it avoids paying a higher rate of interest on the loan than the sinking fund can earn. The total cost of a loan of $100,000 for twenty years, interest compounded annually for the three types is as follows:—

*Paper read before the Second General Professional Meeting of the Engineering Institute of Canada, Saskatoon.

| Annual Interest on Bonds. | Sinking fund compounded annually at 3%. | 3½%. | 4%. | Annuity. | Serial. |
|---|---|---|---|---|---|
| | $ | $ | $ | $ | $ |
| 4 ...... | 154,431 | 150,722 | 147,163 | 147,163 | 142,000 |
| 4½ .... | 164,431 | 160,722 | 157,163 | 153,752 | 147,250 |
| 5 ...... | 174,431 | 170,722 | 167,163 | 160,485 | 152,500 |
| 5½ .... | 184,431 | 180,722 | 177,163 | 167,359 | 157,750 |
| 6 ...... | 194,431 | 190,722 | 187,163 | 174,369 | 163,000 |

Consider now by what form of levy or taxation the requisite funds are to be obtained. The several systems of finance as practised on this continent may be summarized as follows:—

No. 1. Province pays the entire cost.

No. 2. Total cost assessed against the property abutting on and improved by the highway.

No. 3. Province pays a portion of the cost and the balance assessed against the rural municipality as a whole, or against the property situate in an "improvement district" bordering on the highway.

No. 4. Province pays a portion, each urban municipality pays a portion of the cost of those roads within a certain radius described about the urban centre, and the balance assessed against the rural municipality benefited.

No. 5. Federal aid for a portion of the cost and balance distributed as under Method No. 4.

No. 6. By a wheel tax, collected either by the licensing of all vehicles or by toll stations.

Methods 1 and 2 are merely mentioned, but should not be favorably considered, as everyone will doubtless agree that both are unfair, illogical and uneconomic, and moreover have a retarding effect on roadway improvement. The remaining four methods are not in the experimental stage, but have all been tried out successfully, which proves conclusively that the probem of finance is a local one for each province to handle, as the equity of each system depends on the relation between local and national finances, the climatic and soil conditions, density of urban and rural population, the manner in which the population is distributed and the nature of their occupation.

### Four Successful Methods

The province of Quebec uses Method No. 3, and is conceded to have a fine system of roads, while Method No. 4 is used in Ontario, where the public is well pleased over the results obtained. With further reference to the procedure adopted under Method No. 4, it is now known that the expenditure of city taxes on country roads is a sound principle. The improvement of market roads results in improved business within the city, as most cities are dependent upon the surrounding country for their prosperity and development. Since the introduction of the motor car, the country highways have been used to an increasing extent by city residents, and it is surely sound logic that they should bear a proportionate cost of the improvement. The placing of the financial burden entirely on the farmer has been practised too long, and is the cause of the slow progress made in improved highways. Europe discarded this practice long ago and portions of the United States more recently. Methods 5 and 6 are in use in the United States, where the Good Roads movement is progressing very favorably. The majority of the States use Method 5, while as for No. 6, a system of toll gates is practised in Virginia, and with such success that the resulting fund not only maintains all the roads, but provides the money for extensions. Also, Illinois proposes to expend sixty million dollars on roads and pay for and maintain them from automobile license fees. Placing the burden of the cost on motor vehicle owners seems at first thought an unfair method, and one burdensome on the motor users. Unfair it admittedly is, and yet every organized body of motorists and every organization of the motor industry in the State is energetically working to secure the passing of the law. The measure increasing the registration fees to a point necessary to finance the whole programme was made law not against, but with the concerted efforts of the motorists. However, this is distinctly class legislation, and, while not so unfair when applied to Illinois, with its vast number of motorists, would decidedly be both unfair and burdensome if attempted in Saskatchewan, but if horse-drawn vehicles were proportionately taxed, then a more logical method of finance would be attained. This wheel tax would not necessarily be paid wholly by those upon whom it was imposed, but would naturally be distributed by those individuals among the persons directly or indirectly benefiting from the carriage of goods over the roads.

### Wheel Tax

Whether or not this wheel tax system could be extended to meet the requirements of this province, or whether it would prove uneconomic by curtailing desirable development through the inadequacy of the funds provided, is an open question and one requiring careful study.

The problem is a vast one, and, with the total mileage of roads in Saskatchewan requiring improvements, may, at first, appear hopelessly beyond our resources, but we must realize that good roads are the basis of the entire transportation system of the country, and as such are not a non-essential. Mr. W. F. Tye, of Montreal, stated not long ago that the non-success of the Canadian Northern and Grand Trunk Pacific railways was due to the lack of a well-constructed highway system to feed their main and branch lines. The prejudice which existed not so long ago against good roads is fast disappearing, and they are now recognized as an economical necessity if this country is to progress as it should. The expenditure must and will be large, but if financed in a proper and logical manner will not be burdensome on the community, either individually or collectively. As stated by Mr. W. A. McLean, C.E., Deputy Minister of Highways for Ontario, at the Good Roads Congress held in May of this year: "Yet roads will not be a financial burden. Heavy in a sense, yes, but in carrying on this war we have discovered that what seems a heavy financial undertaking is purely an attitude of mind. If we want good roads, we can pay for them. The financial cost that we have undertaken through this war would have previously seemed impossible to the most efficient of our financiers. To-day we see how it was accomplished. To-day the road problem payment seems heavy. When it is paid for, we will discover that we only had to do a day's work at a time, and a year's work was finally accomplished, and we paid for it through our daily earnings at the end of the year, and it was not such a heavy burden after all."

A discussion on highway finance would not be complete without considering the very essential subject of maintenance. This is a question partly of management and partly of finance. The only too common tendency is to neglect the maintenance of roads which have in many cases been built at great expense. Unless an adequate

*(Concluded on page 166)*

## RURAL COMMUNITY WATER SUPPLIES*

By E. L. Miles
Inspecting Engineer, Department of Irrigation

I AM very much pleased at this particular time to give an account of a few of my observations while acting as an inspector of water supplies in the province of Saskatchewan, for the Irrigation Branch of the Department of the Interior, during the field seasons of 1916 and 1917 and the part of 1918 just past. I am pleased for two particular reasons: First, because I wish to help in some way to make this gathering successful and encouraging, and second, because I feel that all engineers should tell their experiences which are always helpful to other engineers, and are always interesting, if for no other reason than that they are engineering experiences.

My chosen subject of "Rural Community Water Supplies" is in itself a very wide subject, inasmuch as it is only in its infancy of development, and to-day there are many destitute farmers, who cannot risk the keeping of a cow on the place on account of the shortage of water. Nothing in my travels caused more wonderment in my mind than to drive into a farm yard in quest of a refreshing drink of water on a hot day and to find that the only available drink was warm rain water, or stale lemonade, backed up with the excuse that the children had not yet gone to town for the water. I wondered what kind of people they were who could endure a life of this kind, especially as there were other lands available in this vast Canadian West where such conditions do not prevail. The growing of wheat is the solution, and strange to say, this extremely dry belt holds one of the best records for wheat production.

### Wet Northeast, Dry Southwest

Owing to the fact that my inspections have been confined to the province of Saskatchewan, I will of necessity confine my remarks to it, and ask you to picture the map in your mind's eye. Generally speaking, it is known as wet in the north and dry in the south, but in reality it is wet in the northeast half and dry in the southwest half, the division being the line of tree or brush growth. This line commences in the northwest at about Lloydminster, and follows down the North Saskatchewan River to a point about half-way between Saskatoon and Prince Alberta, thence in a southeasterly direction to the southeast corner of the province. The growth in the wet area starts with small poplar and willow, and gradually grows into the larger type as one proceeds north, until township 55 is reached where timber of spruce and hemlock is obtained fit for saw-mill purposes. Over this territory, surface water as well as ground water is found in abundance and nearly all the streams are perennial. Drainage schemes are numerous in the flatter parts, which indicates considerable "spoil land."

The southwestern part of the province, known as the dry part, is mostly open prairie, and surface water is very scarce in the summer and fall of the year. The old creek beds and sloughs become dry so that underground water has to be found, or else surface water impounded and held for dry seasons. Groundwater is not, as a general rule, hard to find, although there are isolated districts which are most difficult and expensive to prospect. In these districts the average farmer is not financially able to procure it by deep-well drilling, and I know of cases where drilling up to 1,500 feet has failed to locate water. In these districts the government has assisted the farmers by creating reservoirs of various types, for the purpose of holding the spring runoff, as well as any precipitation which might occur during the summer. In the early days, stock watering reserves were located along the principal rivers for the benefit of the ranchers. A great many of these, however, have been cancelled, and the balance are now on the slate for inspection, to determine their value. Those in Saskatchewan were located principally along the South Saskatchewan River and in the Cypress hills.

Generally speaking, small towns and villages are in a primitive state as regards their water supplies. In some cases water is hauled from neighboring springs and sold to the residents in pails or by the barrel. This, however, is due to the lack of funds which might better the conditions. In other cases the town pump is in evidence at the principal street corner. The larger towns have their own systems, which is a subject in itself.

### The Act Respecting Irrigation

This act, composed and operated by the Dominion Government, through the Department of the Interior, for the benefit of the two prairie provinces (Saskatchewan and Alberta) as regards the administration of water rights, is probably the most argumentative law known when directly applied to the farm. Besides the regulations it contains for the irrigation of land and the purchase thereof, it also administers and regulates the use of all water which flows on the land, whether it be through a city or the smallest farm. In proof of this I will recite the following rulings as contained in the act:—

"The property in and the right to the use of all the water at any time in any river, stream, watercourse, lake, spring, creek, ravine, canon, lagoon, swamp, marsh or other body of water shall, for the purpose of this Act, be deemed to be vested in the Crown," etc. Also

"No person shall divert or use any water from any river, stream, watercourse, lake, creek, spring, ravine, canon, lagoon, swamp, marsh, or other body of water, otherwise than under the provisions of this Act," etc.

You will note that these rulings contain the words watercourse, spring, ravine, marsh, and all other bodies of water, and it is for this reason that the average farmer becomes indignant when he finds that his right to the surface water on his own farm is limited. He immediately proceeds to tell the inspector how he wandered back onto the desert prairie in the early days to locate a homestead and spent many days in search of water for farming purposes, passing up most desirable land because the prospects for obtaining or storing good water were poor. Now he finds that the man who came later and took up the more desirable land has almost an equal right to his water supply, or can, through this act, obtain such a right. This fact is particularly annoying if the farmer has, through his so-called wisdom, succeeded in locating a spring. This spring, if it happens to be the only one in the neighborhood, is looked upon by this lucky farmer as a divine right, and by reason of it he invites his desirable neighbors to partake of it. But there is in all communities an undesirable neighbor (from Bill Smith's point of view), and he is barred the privileges which the other neighbors enjoy. He is, therefore, often compelled to seek the assistance of the whole community through the council of the municipality in order that he too might enjoy an equal right with his neighbors. The municipality then find that they either have to adjust the water-

*Paper read before the Second General Professional Meeting of the Engineering Institute of Canada, held at Saskatoon, Sask., August 8th-10th, 1918.

proposition on Bill Smith's farm or else ask John Jones to leave the country. But the government has spent a lot of money in getting John Jones to come to the country and take up land, and as he is a good farmer and a desirable citizen and despite this personal quarrel with Bill Smith, they want him to stay. So, through the working of the act, the eternal gratitude business attached to Bill Smith's spring is removed.

The act, however, where watercourses are concerned, has a far wider effect than the mere administration of water for the benefit of any particular community. These watercourses are unit parts of large drainage basins and go to make up the larger streams and rivers of the country, on which certain large industrial, municipal and other rights have been granted, and these, of course, have to be protected. The department should, therefore, know all the details of every scheme located in the drainage basin, more particularly the quantity of water held in storage. No farmer, on account of his riches, should be allowed to create a lake for the purpose of canoeing or other pleasures, if in so doing he holds up the natural runoff to the detriment of others. This, however, is not a serious question at the present time, but the time will come as the country becomes more thickly settled, and dry seasons occur, when lawsuits will be numerous and costly.

Through the information furnished by the hydrometric service covering the larger streams, and the inspections and reports on the various schemes in the drainage basins, water administration can be handled in a form of bookkeeping, and in this way the department has an intelligent check on the water supply of the territory, over which the act has jurisdiction.

### The Spring

The spring is, of course, the most-sought-after source of water supply in these dry districts, being perennial by nature, and because of the purity of the supply. There is, however, a wide diversity of opinion as to the limits of the jurisdiction of the Irrigation Act in comparison with the development which might bring the scheme under the heading of a "well".

The difference, in my opinion, is simply this: where a man of his own ingenuity finds water by digging into the surface soil, the water found by him is his own property, to do with as he may see fit. If, however, he finds a surface indication of water, if only in the form of a miniature marsh, and by developing this indication by any means whatsoever, he produces a constant supply which of itself remains constantly at the surface or near it, this supply is a spring water supply and the right to it is vested in the Crown. The Crown, of course, reserves to the land owner the first rights to the supply, and the balance, if any, is licensed to the applicant.

The development of springs depends largely upon conditions, but for rural communities the general rules are as follows: First, to establish a graded road to and from the site, next to construct a box to which a pumping appliance can be installed, and next, the excavation of a reservoir for the use of stock. Sketch No. 1 attached shows the general layout for development of community springs.

### Reservoirs

This is, indeed, the most interesting type of water supply development from an engineering standpoint, inasmuch as the construction of the dam requires considerable engineering judgment, especially in view of the fact that stone and concrete are not always available in these dry districts. The best and most efficient reservoirs which have come under my observation is the combined reservoir and dugout in narrow coulees, say, up to a depth of about 50 feet, where the supply is more readily replenished from the larger drainage basin or watershed and the reservoir is protected from hot winds, etc. They are less susceptible to flooding, and depth of water is obtained by means of a dugout. The dam is usually low, and the spillway problem is therefore more readily solved. The spillway capacity is invariably under-estimated; that is, they are built for normal conditions rather than extreme flood conditions. The extreme floods occur about once every seven years and when they do occur it is common to find about 75 per cent. of the dams washed out. I am a strong advocate of placing the spillway always at the side of the dam in the natural ground, rather than in the centre, even though the spillway be constructed on piles, as I sometimes find them.

Community dams are usually built on road allowances, the top being used as roadways. This has been disputed

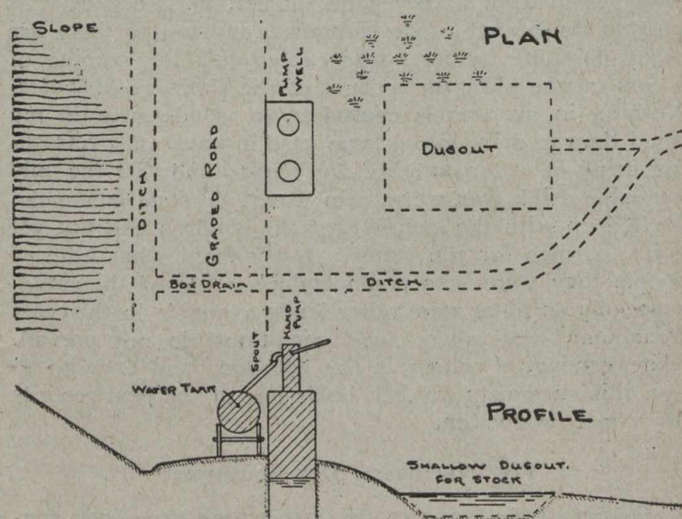



**Fig. 1—General Layout of Community Springs**

as "good practice," but I am personally in favor of it, especially on account of having the water convenient to the highway, and the fact that the work is not duplicated. The inconvenience to travel by reason of washouts occurs in any case, and we are living in hopes that the day will soon come when these yearly washouts will be stopped by better engineering construction, even though it means greater initial cost in the first place.

A brief form of instructions for the construction of a dam aside from the general specifications as to dimensions and slopes might be cited as follows:—

On commencing the construction of a dam it is important that the site be entirely stripped of all sod and vegetable matter, and that same be removed to a convenient point, to be used after to sod down the top and lower slope, on completion of the work. The ground thus stripped should have furrows ploughed every four or five feet, at right angles to the coulee, in order to give a rough surface to the ground to resist seepage. The puddled wall trench should then be dug to a depth well below the top soil or loam, into an impervious strata and the trench rebackfilled with a selected clay, and well puddled with water. When this trench is filled the main portion of the dam should be commenced, and the material used should be a suitable clay, free of vegetable matter and stones. The borrow pits which should be located on each side of the dam on the upper side, should therefore be stripped of both sod and top soil. The material should be spread on in thin layers, and well consolidated by tamping, but special runways should be avoided. It is also important that the sides be carried up considerably faster than the centre, and that the centre immediately over the puddle wall be continued up into the embankment for at least 3½ feet.

On completion of the earthwork, cobble-stone rip-rap should be placed on the entire upper slope, to assist the clay to maintain its slope as, well as to prevent wave wash from wind. If cobble-stones are not available, lumber is sometimes used for this purpose, in the form of an ordinary board fence constructed in the slope. Shrubs are often planted from the water line to the top on the upper and on the entire lower slope. The balance of the earth work should then be seeded down, after the available sods from stripping have been placed.

The spillway must take care of the entire runoff after the dam has been filled, and in no case is any water to be permitted to go over the top of the dam. Providing the owner can afford this expense, the spillway should be paved with concrete or hand-placed rip-rap for a distance of about 20 feet on each side of the centre line of the dam, and the paved portion should be level so that the current in it will be reduced as much as possible. After leaving this portion, care should be taken to ditch the waterway from the embankment, and the ditch should be well rip-rapped to prevent erosion.

Ofter completion, the embankment should be inspected from time to time, and any defects, such as settlements, rain wash, wear from stock tramping, or damage from burrowing animals, should be repaired. Special attention should be paid to the spillway after the spring run-off to see that the rip-rapping is not undermined or washed out.

Reservoirs of the type outlined above with the spillways at or above the high-water line are, of course, difficult to clean, but they are built nowadays in this manner as a matter of economy. Sluice pipes equipped with

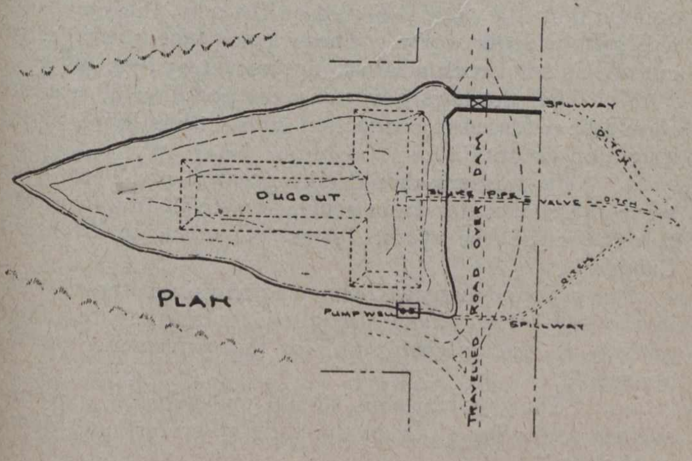



**Fig. 2—General Layout for Community Reservoirs in Coulees**

valves, or concrete spillways equipped with stop logs or gates would, of course, make them more complete.

In some private schemes I have found some very unique forms of construction, especially where people from foreign lands have constructed the dams. One form is to build a rustic fence of poles, interlaced in a strong manner, and then covered with earthwork, having the fence sticking up through the upper slope at the high-water line. Sometimes this fence is seen on the lower slope, and where this type is used the dams are usually intact, while others nearby have been washed out of existence.

Sketch No. 2 shows a general layout for community reservoirs in coulees.

### Dugouts

The most peculiar form of reservoir is the dugout located on the flat open prairie in heavy gumbo soil. These dugouts are generally about 200 feet long by 50 feet wide and from 10 to 15 feet deep, with sloping sides,

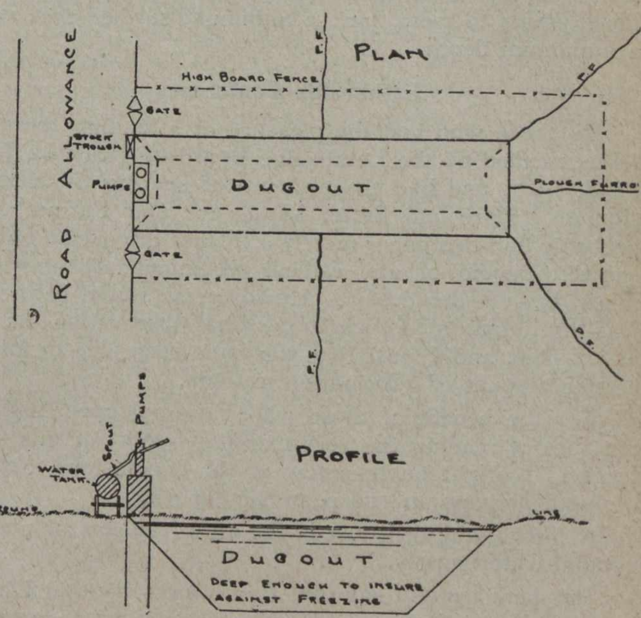



**Fig. 3—Layout for Community Dugouts on Open Prairie**

holding about 700,000 gallons of water. They are equipped with pumping appliances for the taking of water, and fenced with high board fences to protect them from pollution. They are rather popular, as the water does not deteriorate very rapidly, on account of the depth and the minimum surface area. Plant life is also kept down, and the cost of construction and maintenance is comparatively low. Dugouts are sometimes located in dry slough beds, on account of the impervious soil and because of the natural location for replenishment. But this is not a desirable location, because of the quality of water in them. It is usually high in color from decayed vegetation, and therefore more infested with insects.

A dugout of this kind will serve an area of about nine square miles, based on the following estimate. The average farm in the grain district is about one-half section or 320 acres of land, each farmer supporting about six persons, ten horses, ten cows, and ten hogs, which will consume about 600 gallons of water per diem, or a little less. So that the estimated water supply for each township would be about 43,000 gallons per day, at all times, or about 72,000 gallons per day in the threshing season, considering that only about one-quarter of the farmers of the township are actually threshing at the same time. The standard dugout of about 700,000 gallons capacity, with four to each township, in addition to the usual private means of water supply, will give a full 40 days supply, which is generally the length of the brisk threshing season for which these 40 days are considered.

Sketch No. 3 shows the general layout for community dugouts on flat open prairie.

### Losses from Open Reservoirs

Just here I might add a few remarks concerning the estimated water losses from open reservoirs. There are two noticeable agents of losses. First, evaporation, and second, percolation. The first means evaporation into the air due to atmospheric conditions, and degree of shade from the mid-day sun and hot winds. The second means that portion taken up by seepage into the ground, plus that portion taken up by plant life. Generally speaking, open reservoirs lose about forty inches per year from these agents, depending largely on the protection as well as the depth. It is advisable to locate the reservoir with these points in view, *viz.*, a minimum surface area with a maximum depth.

### Lethbridge Conference

To those who had the pleasure of attending the conference called by the Lethbridge Board of Trade on June 22nd, 1917, and had the pleasure of hearing the discussion on "More and Better Water for Our Farms" will probably find this paper merely a further discussion on the subject, devoid of any radical recommendations which might be considered new. However, as stated before, it was my intention to stick to personal observations as far as possible, and I trust that you have been able to find a certain amount of information in them.

For the benefit of those who have not even had the pleasure of reading the very excellent report of this conference, I might quote a few of the conclusions arrived at, with perhaps an odd personal remark.

1. "That the drill test is the only true test of underground water supply."

Just here I might say that I am very sorry that I have been unable to find anybody who was willing to prepare a paper on "Deep Well Drilling." Few engineers have had very much practical experience in drilling, and therefore it is most difficult to prepare specifications which do not conflict with the practice, and which will cover any contingencies which might occur.

2. "That the governments should undertake these tests for the benefit of the farmer."

The Dominion Government has already explored a part of the artesian water area in Southern Alberta, with most excellent results. I had the pleasure of visiting one of their wells near Pakowki Lake, where a discharge of about 30,000 gallons per diem is obtained of most excellent fresh water. This well was about 650 feet deep, having been drilled with a 3-inch rotary drill, and only cased at the top and bottom. The top is efficiently capped and the bottom protected from caving by means of a packer.

3. "That efforts should be concentrated on making the drilling of these test holes as inexpensive as possible and the best way to do this is to use the rotary method of drilling."

This, I suppose, covers the test wells for artesian water.

4 "That no water witch or water machine has yet been developed which is in any degree efficient or to be relied upon."

### Sapper Kelley at Gallipoli

This is rather contrary to the experience of Sapper Stephen Kelley, known as an expert diviner in Australia, having located many shallow sources of water supply for the sheep herders of his country. It appears that the water supply for the Gallipoli campaign was brought to the troops from outside sources by tank steamers. This being very difficult on account of the gun fire from the Turks, the troops were often short of water. Sapper Kelley being a sufferer from wounds as well as from thirst, got up from his bed, straightened out the flange of a Turkish shell which he used as a divining rod, and located a prospect, which, on digging to a depth of six feet was found to yield a flow of 2,000 gallons of water per hour. The shortage was at once obviated and the trench manned with a rejuvenated army. The extreme shallow depth and Mr. Kelley's keen observation had undoubtedly much to do with this success.

It does not seem reasonable, however, that scientific electrical water finders should be entirely failures.

5. "That the provincial government road department should aid in the construction of surface reservoirs in places along the road allowances where roads must be built across coulees."

The provincial government of Saskatchewan has carried out this policy in a very effective and considerate manner.

6. "That a law should be passed forcing drillers to keep a log of every well and send it to the government."

7. "That a law should be passed making it unlawful to allow any artesian wells to flow unchecked, as the conservation of underground waters is important, being in fact, the most important of all our natural resources."

This law should be passed and understood before the wells are drilled because once the water starts to come to the surface outside of the casing it is almost impossible to stop it. I know of one flowing well near Nakomis, Sask., where this well is causing considerable damage to land and roads, but it cannot be stopped as the drill did not enter rock, and more water is coming up around the casing than through it. The government well at Pakowki Lake also has a leak around the casing and it is my opinion that if a valve is placed on the pipe, this condition will simply grow worse. These leaks can, however, be cut off, as solid rock was encountered at 65 feet.

8. "That the laws governing the pollution of streams should be enforced in connection with settlers living along irrigation canals."

9. "The farmers should take greater pains to conserve the rain water from roofs; waste in this direction being one of the worst forms of waste in Western Canada."

I have found many well-constructed rain-water cisterns in the dry belts. They are often equipped with hand pumps at the kitchen sink, for the convenience of the household.

10. "That the farmers should endeavor to conserve surface water for stock by building reservoirs and dams in coulees."

In addition to the public schemes along the highways almost 50 per cent. of the farmers have private reservoirs of some kind of their own for the purpose of watering stock, but they are generally nothing better than duck ponds, and being close to buildings and uncared for, they are often very rank. Occasionally I find the dam built of nothing better than manure.

These seem to be the main and essential points of the Lethbridge convention, but I would certainly recommend that those who have not read their report should do so at the first opportunity.

### Conclusion

It is my opinion that the problem of water supply is going to become more acute as the country becomes more

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# The Canadian Engineer

Established 1893

*A Weekly Paper for Canadian Civil Engineers and Contractors*

Terms of Subscription, postpaid to any address:

| One Year | Six Months | Three Months | Single Copies |
|---|---|---|---|
| $3.00 | $1.75 | $1.00 | 10c. |

Published every Thursday by
The Monetary Times Printing Co. of Canada, Limited

*JAMES J. SALMOND* — *President and General Manager*
*ALBERT E. JENNINGS* — *Assistant General Manager*

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
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## Principal Contents of this Issue



## CO-OPERATIVE METER READING

NEARLY every city residence contains two meters and many contain three meters, each of which is read every month by a different man. "It is perfectly feasible for one man to read all the meters in a house," suggests Engineering-Contracting, of Chicago, "and with almost as great expedition as the reading of only one meter. Moreover, it would be feasible to send all three bills—for water, gas and electricity—in one envelope."

The only difficulty in the way of executing such a program of economy arises from the fact that ordinarily these three utilities are supplied by different companies or by different departments of a city. But this difficulty is not so great as to inhibit the application of such a commonsense plan of reducing the expenses of meter reading and billing.

Certainly it lies within the power of public service commissions to require water, gas and electric companies to perform work jointly, and to prorate the joint expense. This is already done in a number of cities where telephone and electric light companies occupy the same poles and conduits with their wires. Probably every city could bring about a joint reading of water, gas and electric meters merely by passing an ordinance compelling co-operative action by public utility companies and city departments.

"We believe it to be a conservative estimate that $5,000,000 can be annually saved in the United States by the joint reading of meters and joint mailing of bills. Capitalized at 5 per cent., this is $100,000,000, which may be called the commercial saving that may be effected by this co-operative plan," says our contemporary. In these days when every bit of waste should be speedily eliminated, this is a capital suggestion, and could well receive earnest consideration by Canadian public officials as well as those in the United States.

## AMERICA'S ENERGY SUPPLY

THAT the economical utilization of America's energy supply requires the generation of electric power wherever hydraulic or fuel energy is available, is the claim made by Dr. C. P. Steinmetz, chief consulting engineer of the General Electric Co., Schenectady, in his article on "America's Energy Supply."

"The power should be collected electrically just as we distribute it electrically," says Dr. Steinmetz. He makes a brief survey of the United States energy supply in fuel and water power and says that the total potential hydraulic energy of that country is about equal to the total utilized fuel energy.

He states that the modern synchronous station is necessary for large hydraulic powers, but that the solution of the problem of economic development of the far more numerous water powers is the adoption of the induction generator, because of its simplicity of control. In his discussion at the meeting of the American Institute of Electrical Engineers, Dr. Steinmetz referred to the problem of recovering some of the fuel power now wasted, and he suggested that simple steam turbine induction generators be interposed between the boilers and the steam heating systems, collecting the power electrically. "The power that could be thus recovered," stated Dr. Steinmetz, "is an appreciable part of the total available power in the fuel."

## MONEY FOR HOUSING

FUNDS up to a total of $2,000,000 are offered to municipalities by the government of the Province of Ontario for the purpose of providing housing facilities. The province offers to lend money to any Ontario municipality at 5 per cent. to meet one-quarter of the expenditure, the municipality itself being required to furnish the other three-quarters. Money at 5 per cent. looks attractive at the present time, as this is much below the current rate, even for provincial borrowings.

This proposal recalls transactions of a similar nature in Ontario which took place over fifty years ago under the authority of the Municipal Loan Fund Acts of 1853 and 1859. The act of the former year authorized the government of the then province of Canada to loan money to municipalities for public works and other improvements at 5 per cent. The province could at that time borrow at less than a 5 per cent. basis, and the difference was intended to pay the cost of administration. The purpose of the act was to provide a greater supply of money and at cheaper rates than the municipalities could secure upon their individual credit. There was no limit placed upon the total to be provided under the act. Accordingly, the act of 1859, which extended the privilege to Lower Canada, limited the total to £1,500,000 each, or over $14,000,000 altogether. In 1867, just fourteen years after the original act was passed, the municipalities of Upper Canada had borrowed from the province a total of $7,400,000, or almost their limit, while Lower Canada had secured $2,428,140. What is more significant, however, is the fact that the Upper Canada municipalities were in arrears of interest to the amount of $3,517,018, and those of Lower Canada to the amount of $782,735. With the utmost confidence in their investments, they had sunk large sums in railroads, both directly through bonuses to roads and through subscriptions to stock, and had also spent large sums in building highways. The counties of Lanark and Renfrew were debited with $800,000, the city of Brantford with the sum of $400,000, Cobalt $500,000, and Port Hope with the comparatively enormous sum of $680,000. The investments had not resulted as expected, and many of the municipalities were quite unable to pay the interest. The result was that in some cases the debts had to be wiped off the books of the province.

The present case, however, is different, as the total is smaller, not only absolutely, but also in relation to the wealth and assets of the municipalities of Ontario. Moreover, in order to take advantage of it, they would have to borrow three times as much at current rates of from 6 to 8 per cent., so that the average cost of the money would in most cases be largely in excess of 6 per cent.

## WOMEN IN DRAFTING ROOM

NEARLY twenty young women are in active training to do drafting work for the Iowa State Highway Commission. So many of the young men trained to this work have been called to war and so many sent out to do actual field work, that it became necessary to take radical means to keep the work of this important department in pace with the needs. W. T. Ide, of the manual training department of the East High School, Des Moines, Iowa, was secured for the vacation period to train a number of young women to do this work. So soon as an individual shows proficiency, she is given actual drawing work. Many more applications have come in than can be accommodated, showing great interest in this new line of work for women. The success of the experiment so far has been such that it is freely predicted that much of the work of the drafting room will continue to be done by women.

## METHODS OF FINANCING FOR GOOD ROADS

*(Continued from page 160)*

fund is provided and utilized for the upkeep of the system, then the money used in construction has been wasted. A good plan, and one becoming popular in the United States, provides that a fund must be provided for in the taxes for use in maintaining roads constructed by means of bond issues, said fund to be kept separate from all other county funds and used only for maintenance. The Federal Aid Road Act of the United States provides that unless roads constructed under the provisions of the Act are adequately maintained, then approval of further road programmes for the section may be withheld until such time as the roads have been properly repaired. There is a growing tendency to tax, by licensing or registration, all vehicles, whether motor or horse-drawn, that use the roads, and it is desirable that the funds raised in this manner should be utilized, either wholly or in part, for maintenance, not as a punishment for the use of the roads, but because there will be a constant proportion between the amount of wear and tear and the amount of money raised. This might be carried further and a tax imposed on gasoline, for then the occasional and the constant user would each pay in absolute ratio to the use made or mileage covered. A tax of this description is levied in England, but the fund into which it goes is not utilized for maintenance, but for construction.

## RURAL COMMUNITY WATER SUPPLIES

*(Continued from page 164)*

settled, and the question is going to require more engineering aid than it has in the past, if the best results are to be obtained.

Signs of insufficient investigations are noticeable at times, such as dry reservoirs, indicating unsuitable soil conditions, and let us hope that the practice of installing incomplete schemes, because of lack of money, or other excuses, will be stopped, if for no other reason than that these dilapidated schemes are bad examples in the country. It is false economy to half build a big scheme. Better to build two small schemes well. This is another case where the Public Utilities Commissions of the provinces could increase their efficiency by making better use of the engineering profession.

## PERSONALS

R. C. HARRIS, works commissioner of the city of Toronto, has resigned as Honorary Fuel Controller for the Province of Ontario.

Prof. R. C. WALLACE, head of the Department of Geology and Metallurgy, University of Manitoba, has been appointed mining commissioner of Northern Manitoba.

R. G. JENCKES, JR., formerly assistant engineer of the Indianapolis Water Co., has joined the staff of the Pitometer Co., of New York, with headquarters at Wheeling, W. Va.

HOWARD G. KELLEY, C.E., president of the Grand Trunk Railway, has returned to Montreal after an inspection trip over the lines in Western Canada. Mr. Kelley went as far as Skagway, Alaska, and to the Yukon.

SAM. J. PORTER has resigned as assistant chief engineer, Irrigation Branch, Department of the Interior, with headquarters at Calgary, to assume charge of the operation of the Lethbridge section of the Canadian Pacific Railway Company's irrigation block, with headquarters at Lethbridge, Alta.

JAMES CARRUTHERS, president of Canada Steamships, Limited, has resigned as director of the newly incorporated Halifax Shipyards, Limited. Mr. Carruthers protested against the formation of a subsidiary wrecking company. The other directors state that Mr. Carruthers' subscription to the enterprise has already been replaced by another.

J. VAN BENSCHOTEN, one of the assistant engineers attached to the New York office staff of the Wallace & Tiernan Co., has been assigned to the General Supply Co., Limited, of Canada, Ottawa, who are Canadian agents for the Wallace & Tiernan Co. Mr. Van Benschoten is a graduate in mechanical engineering of Syracuse University and for several years has paid special attention to problems concerning the application and control of chlorine in the sanitary field.