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The Canadian Engineer

A Weekly Paper for Civil Engineers and Contractors

Protection of Owners on Cost-Plus Contracts

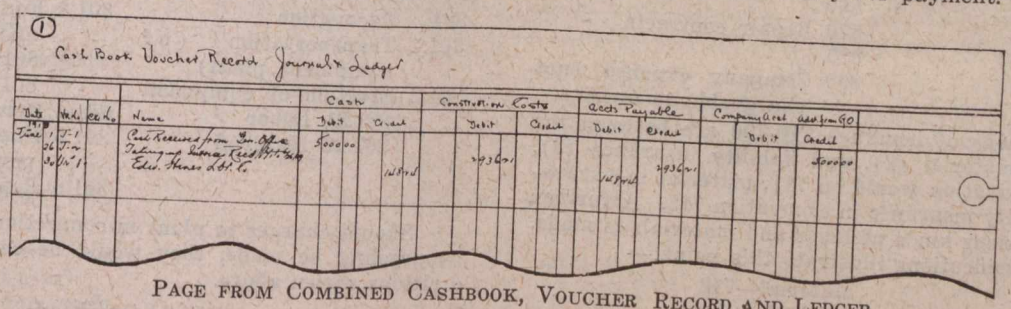
Practical Use of Dewey Decimal System in Keeping Books on the Job—Open for Inspection by Owners and Their Engineers and Architects—Distribution of Accounts—Classification of Plant Expense and Field Overhead

By F. A. WELLS

Vice-President, Wells Bros. Construction Co. of Canada, Ltd.

NO contractor who values his capital can afford to do without adequate cost records, both as a check on the job in progress and as a basis for future estimating. Yet the simpler that system of accounting, the better, and any refinements further than those necessary to give the actual required data are a waste of time and money. Some contractors keep their books under their hats or in their left-hand pocket of their coats, where all invoices go preparatory to paying. At the opposite extreme are firms who maintain a complicated system of accounts, both at the job and at the home office. Accounting methods sufficient for the lump-sum contract may be insufficient for the cost-plus-fixed-fee contract, under which the owner and his engineers and architects must have access to the accounts at all times.

The following system has been found adequate for cost-plus jobs, and with only a few changes this is the system put into effect on such typical work as that which we have done during the last few years for The Robert Simpson Co., Ltd., Toronto, and for the William Davies Co., Ltd., Toronto.



PAGE FROM COMBINED CASHBOOK, VOUCHER RECORD AND LEDGER

Occasionally we have found an owner who prefers to be given such data as will permit his own accountants to keep a complete system of books. Generally however, our accounts, kept on the job and open at all times for inspection, are considered sufficient, in view of the detail statements we render to the owner every two weeks, bearing the approval of the owner's representative, who is designated for that purpose. We urge owners to have their auditors frequently make examinations of accounts for their own satisfaction.

The system we are now using is briefly the keeping of:—(1)—Cashbook, voucher record and ledger, combined; (2)—Invoice and payroll register, combined; (3)—Detail cost record; and (4)—Accounts payable record (vendors' accounts).

The cashbook, voucher record and ledger is used for the recording of all cash received, cash disbursed by voucher and all journal entries.

The invoice and payroll register is used for the recording of all invoices and payrolls. The invoices and payrolls are numbered consecutively. This register has columns for date, invoice number, vendor's name, total amounts (both debit and credit) and individual columns for the 20 main accounts used in distribution of costs. The register represents an absolute detail control of all approved charges to the job, as only audited and approved items are given a register number or entered. The payrolls are given register numbers and approved the same as invoices. The office copies of all invoices are filed in numerical order in an ordinary letter file drawer, and bound in numerical order, in lots of 50 to 100, using an ordinary heavy file folder for cover, clamping the invoice to the folder.

The detail cost record is used for recording in detail the distribution of costs among the main accounts as shown on invoice register.

The accounts payable (or vendors' accounts) record is used for the recording of all invoices from vendors. After the invoices have been entered in the invoice register and detail cost record book, they are entered as a credit to vendor in accounts payable. Each vendor has a separate page or sheet. After entry is made, it is placed in file under vendor's name until ready for payment. When payment is made, same is vouchered and charged to accounts payable (vendors' account) and cash credited.

Issuance of purchase order (in quadruplicate).—The original of order is sent to vendor, the duplicate is filed numerically (which forms order register), triplicate is filed in open order file (vendor's name order), and quadruplicate (which forms material receipt or tally sheet) is filed by the office material clerk awaiting receipt of material.

Receipt of material.—Upon receipt of materials, the office material clerk checks and signs the material receipt portion of the order and files completely with supporting delivery tickets, etc., awaiting invoices.

Checking and auditing invoices.—Invoice upon receipt is checked against material receipt or tally sheet for receipt of material. Extensions, prices and footings are checked and certified. Cost distribution is checked and entered. Invoice is then audited for discount and cost distribution and certified. Invoice then passes to the superintendent for his approval and the approval of the owner's representative.

Entry of approved invoices in invoice register and vendor's account.—Upon return of approved invoice from the superintendent, the bookkeeper gives the invoice numerical register number and enters in the invoice register. Only fully approved invoices are given register number. Invoice is then posted to the credit of the vendor in accounts payable account and are charged in the detail cost record.

Journalizing accumulated totals of invoices registered to ledger.—Accumulated totals in the invoice register are journalized in the ledger (which is also the voucher record)

at daily, weekly or semi-monthly periods as is found practical.

Voucher check.—We have found the voucher check system to be the most convenient. The voucher is made in quadruplicate at the construction office on the job and the approval of the owner's representative is often indicated on all copies of the voucher. The check, or original voucher goes to the vendor, the duplicate to our general office for our records, the triplicate is kept as the job record and the quadruplicate is the "owner's copy," which is forwarded to the vendor with original to be receipted by him and returned. At intervals we furnish the owner with statement showing vouchers paid and receipted vouchers attached.

Since the major purpose of cost accounting is to give an adequate basis for future estimating, it is important that so far as practicable the form of cost accounting shall follow the form of estimate. This is not practicable to the last subdivision of each of the general accounts, but sufficient to permit intelligent use of all cost figures. With such figures it is possible to compare not only final costs, but costs at any stage of the job, with the original estimated cost for that portion of the contract. We frequently divide our estimate by floors, in the case of a many-storied building, in order to have a check upon quantities and upon expenditure at several stages of the work.

Distribution of Accounts

We use the decimal system of classification of accounts. The classifications number 100 to 600 inclusive and 900 are for our general books, which embrace the assets and liabilities, revenues and income accounts (we will omit these in our discussion). The general distribution is under the following headings:—

710 Excavation	810 Field overhead
720 Caissons	820 Extra work
730 Footings	830 Subcontracts
740 Trench and wall	840 (Subcontract) extra work
750 Concrete and fireproofing	850
760 Masonry	860
770 Carpentry	870 Repair contracts
780	880
790	890 Company expense (not chargeable to owner)
800 Plant expense	

The sub-divisions of headings 710-790 are between the items labor (1), material (2), and liability insurance (3). Thus labor in excavation would be 711, material in excavation 712 and liability insurance in excavation 713. A further division of the various kinds of labor and materials is made. The following classifications illustrate this point:—

Labor—711	Material—712
711.01 Digging (general)	712.01 Lumber
711.02 Digging sub-basement	712.02 Underpinning adjacent buildings
711.03 Sheeting and bracing banks	712.03 Rings (steel)
711.04 Shoring adjacent buildings	712.04 Cement

For convenience we have listed the charges of labor and material in the order they usually appear in building construction costs:—

Labor	Material
.01 Digging (general)	.01 Lumber
.02 Digging sub-basement	.02 Underpinning adjacent buildings
.03 Sheeting and bracing banks	.03 Rings (steel)
.04 Shoring adjacent buildings	.04 Cement
.05 Underpinning adjacent buildings	.05 Sand
.06 Pumping	.06 Stone
.07 Back-filling and grading	.07 Brick
.08 Cutting old footings	.08 Wall tie and inserts
.09	.09 Steel (structural)
.10 Placing lagging and rings	.10 Steel (reinforcing)
.11 Ventilating	.11 Nails and wire
.12 Mixing and placing concrete	.12 Clamps, purchased or rented
.13 Building forms general	.13 Tile
.14 Building forms exterior columns	.14 Protection (lumber, etc.)
.15 Building forms interior columns	.15 Terra cotta
.16 Building forms spandrels	.16 Granite
.23 Lay brick	.25 Frames and sash
.26 Bend steel	.30 Interior trim
.35 Set cut stone	.35 Coping
.44 Fit and hang doors	
.56 Unload and handle material, etc.	
.60 Clean up rubbish	

Add as many new accounts as are needed.

Should charges be made in connection with concrete and fireproofing under subdivision 750, they would follow the same order as in excavation:—

751.12 (Labor) mixing and placing concrete
752.04 (Material) cement
753 Liability insurance

Or, carpentry, sub-division 770:—

771.44 (Labor) fit and hang doors
772.25 (Material) frames and sash
773 Liability insurance

Classification of Plant Expense

Sub-division 800 covers plant expense and conforms with the sub-classification of the 700 accounts as much as practicable. The following are the headings under 800:—

801 Excavation	806 Masonry
802 Caissons	807
803 Footings	808
804 Sawmill	809 General (items charged to general equipment)
805 Concrete and fireproofing	

A further typical subdivision of the accounts under this heading is:—

801 Excavation	801.3 Equipment on charge and credit basis
801.1 Transportation (of equipment plant)	801.31 Labor
801.2 Erection of equipment	801.32 Material
801.21 Labor	801.4 Rental of equipment
801.22 Material	801.5 Fuel, lubricants and power
	801.6 Repairs

Should charges to plant in connection with concrete and fireproofing be made, they would be charged as 805 with divisions shown above.

Field Overhead

811—Salaries, general labor and expense	*812—Engineering expenses*
811.1 Superintendent and engineers	812.1 Plans, detail and engineering supplies
.2 Office employees	.2 Photographs
.3 Material men and timekeepers	.3 Engineering service
.4 Laying out building	.4 Architects' fees
.5 Watchman	
.6 Waterboys	
.7 Toolmen	
.8 Liability insurance, superintendent and watchman	
.9 Travelling expenses, superintendent, engineers, and office men	

813—Office expense

813.1 Rent, light and heat	.6 Rent on adding machine and typewriters
.2 Stationery and printing	.7 Furniture
.3 Telephone	.8
.4 Telegraph	.9 Miscellaneous office expense, towels, etc.
.5 Postage and express	

814—Other fixed expenses
814.1 Bonds (maintenance and construction)
.2 Permits and licenses, boiler inspection
.3 Fire insurance
.4 Legal services
.5 Burglar insurance
.6 Association dues
.7 Advertisements
.8 Floor tests
.9 Ring tests

816—Temporary structure (labor and material)
816.1 Offices
.2 Toilets
.3 Toolhouse, blacksmith shops, storage sheds, etc.
.4 Stairs and ladders
.5 Fences, sidewalks, covers and other enclosures
.6 Temporary platform and driveways
.7
.8 Repairs and protection to adjacent property
.9 Protection to public utilities

818—Temporary light, heat and power
818.1 Light .2 Heat .3 Power

819—General cleaning
819.1 Labor .2 Teaming

820—Extra work
821.1 Use as many numbers as account charged

830—Subcontracts
831 Wrecking, excavating, shoring, etc.
831.1 Wrecking, contract
.2 Excavation, contract
.3 Shoring, contract

832—Heating, plumbing, wiring, elevators, etc.
832.1 Sub-heading for each kind of subcontract
833—Interior construction
834—Painting and glazing
835—Millwork
836—Roofing
837—Fireproof doors and windows
838—Interior finish
839—Structural steel

840—(Extra work) subcontracts.
841 Sub-headings for each kind of work done

870 Repair contracts (for small jobbing contracts)

890—Company expense (not charged to owners)
891 Sub-headings for each kind of expense

Statement of Construction Cost

At stated periods we take from the cost records a summary and detail statement of construction costs in the following form:—

Acct. No.	Name of Acct.	Item	Amount	Cost per Unit	Est. Cost	Diff.

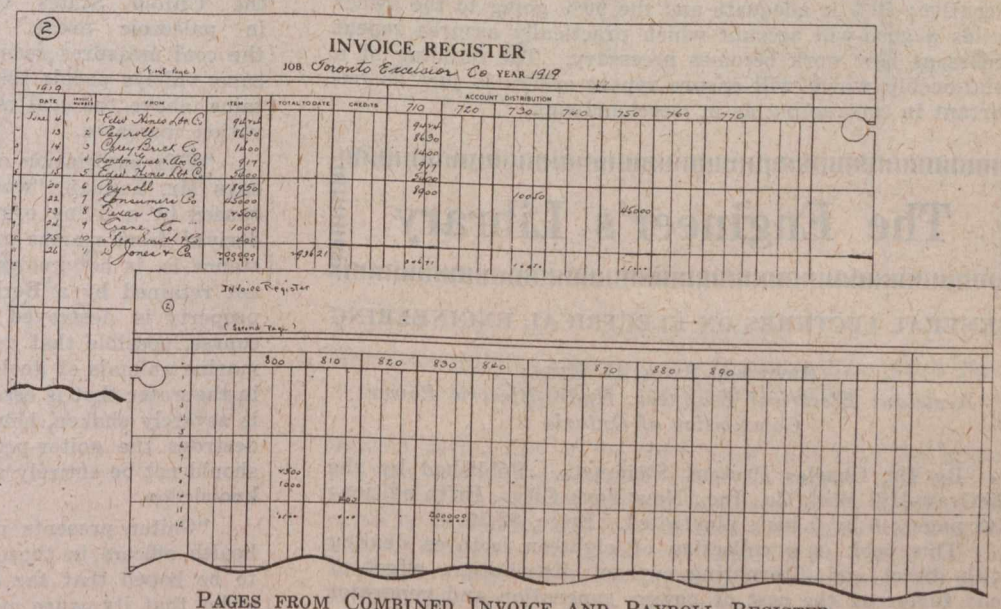
The last column is in black or red; naturally the red items will have careful scrutiny to ascertain why costs are running above estimate. This statement is primarily for our own use, but the owner may have a copy if he wishes.

Owner Knows Total Expenditure

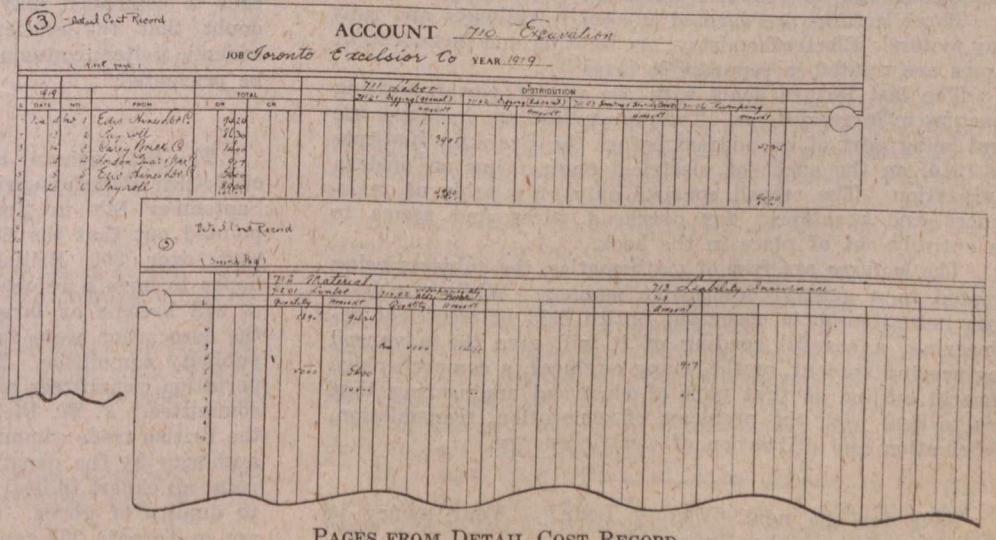
Under the cost-plus-fixed-fee contract, the owner generally furnishes the funds to finance the contract. We maintain an entirely separate bank account for each cost-plus contract, representing the owner's funds, and where agreeable to the owner, we arrange for the owner's representative to countersign all checks drawn by us on this account. At the start of the work we furnish to the owner an estimate of the anticipated amount of labor and material bills covering an initial period of two weeks or more, and the owner then advances the funds to cover these requirements. When the owner's receipted copies of vouchers covering this period are returned from the vendors, a statement is given to the owner showing amounts actually paid for payrolls, materials and sub-contract work, with receipted vouchers attached. That total is then credited to us by the owner on account of contract.

The advantages of having all accounts handled at the job are apparent. The distribution, if not clear from the purchase order, can be referred to the superintendent and the fact that the books of accounts are at all times open for the owner's inspection, is an assurance to him of honest treatment. The fact that he approves purchases of materials before made and again has the opportunity of questioning invoices prior to payment, leaves the control with him and prevents the accumulation of minor, disputed items, which if left for settlement until the completion of the contract, might not be readily explained.

But a system of accounts, no matter how perfect, cannot influence the cost of work except as it points out from time to time divergence from the preliminary estimate, the assumption being made that such differences are promptly taken in hand, the reasons investigated and the remedy applied. The success of work under the cost-plus contract



PAGES FROM COMBINED INVOICE AND PAYROLL REGISTER

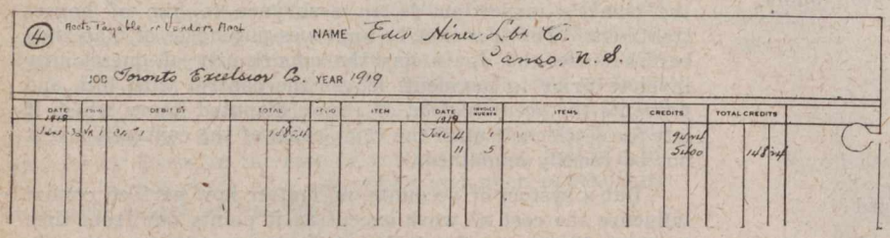


PAGES FROM DETAIL COST RECORD

is still dependent upon the integrity of the contractor and his ability to perform.

We have used this system of accounting with entire satisfaction to the firms mentioned above and many others, and we are now engaged in work at Halifax, N.S., on this same basis. This is adequate proof that the cost-plus contract is workable and that the owners not only feel safe but prefer this method because under it 90% of the savings under the preliminary estimate accrue to the owner, because the 10% retained by the contractor is a reasonable incentive to make every possible saving, and because additional costs incurred through no fault or omission of the contractor are rightly chargeable against the owner and should not reduce or wipe out the contractor's profit.

There is incentive for the contractor to make all pos-



PAGE FROM ACCOUNTS PAYABLE RECORD

sible savings under both old and new contract, and some of the savings must go to the contractor to give him that incentive; 10% is adequate and the 90% going to the owner builds a good-will account which practically assures repeat orders as new work becomes necessary. The building of a relationship which will ensure repeat orders is just as important in contracting as in merchandising.

The Engineer's Library

GENERAL LECTURES ON ELECTRICAL ENGINEERING

REVIEWED BY A. H. HULL
Assistant Electrical Engineer, Hydro-Electric Power Commission of Ontario

By Dr. Charles Proteus Steinmetz. Published by the McGraw-Hill Book Co., Inc., New York City. Fifth edition; 248 pages; 6 by 9 ins.; illustrated. Price, $2.50.

This book is a collection of eighteen lectures dealing with direct and alternating current distribution, effect of load factor on the cost of power, generation and generator wave form, hunting of synchronous machines, transmission, oscillations and surges, and lightning protection.

Three lectures are devoted to electric railways and railway motors. Electrochemistry, arc lighting and incandescent lamps are treated in separate lectures.

The last lecture deals with the use of power limiting reactors in large systems. Two appendices are included, the first being part of an address before the Franklin Institute in 1914, on the effect of electrical engineering on modern civilization. The second consists only of a table of resistances and reactances for overhead wires and seems to be entirely out of place in the book.

The lectures are free of mathematics, the subjects being treated in a general descriptive manner. While the book does not attempt to cover the entire field of electrical engineering, a careful reading of it will give the advanced engineering student, or the young engineer, a comprehensive general outline of that part of electrical engineering that has to deal with the problems of generation, transmission, distribution and utilization of electric energy.

Save for the next "Victory Loan." Your money is needed to ensure national prosperity.

RELATION BETWEEN WATER SUPPLY AND GOITER

AN apparent connection between goiter and water supply in various parts of the world is traced by Mayo Tolman, chief engineer of the West Virginia State Department of Health, Charleston, W. Va., writing in the "American Journal of Public Health."

Goiter, which manifests itself as an enlargement of the thyroid gland, shows high endemicity in Switzerland, parts of France, and in regions in every continent. In North America the main endemic centres are in parts of New Hampshire, New York, the Blue Ridge Mountains of Virginia, nearly all of West Virginia, the region about the Great Lakes, and Edmonton, Alt. Recent studies by Mr. Tolman indicate that there are 12,000 cases in West Virginia, while in Broxton County a house-to-house survey showed 1,148 cases, or 1 to every 20 inhabitants.

The cause of the disease is most generally attributed to the character of the drinking water. Efforts to connect the disease with various inorganic impurities in the waters of the region have not been successful, Mr. Tolman states. The relation seems to be with the geological ages of the rocks of the regions.

"Apparently," Mr. Tolman says, "volvanic formations, the crystalline rocks of the Archaic period and all deposits laid down in fresh water, are free from the goiter-producing characteristic." In the United States the greatest endemicity is found in paleozoic areas. In West Virginia water from the coal measures seems to cause the disease, while in the same valleys people taking water from higher in the mountains, above the coal measures, have less goiter as the elevation increases.

"This association of goiter with certain geologic time," says Mr. Tolman, "would indicate that the disease is not caused by a living organism, but is due to some substance derived from marine animals in past time. What this substance is, is not known, but experiments indicate that it is not retained by a Berkefeld, and that its goiter-producing property is destroyed by heating to 70 deg. C. It is, of course, possible that goiter is a deficiency disease, that the marine animals of geologic time used up a certain substance in the water that is essential to animal economy. This theory is severely shaken, however, by the fact that heat evidently destroys the goiter-producing element, but nevertheless it should not be entirely abandoned at the present stage of our knowledge.

"Goiter presents phases that should be of interest to health officers in those areas in which it occurs, and it is to be hoped that the disease will be given more study in order that its cause may be definitely determined, for without accurate knowledge of the cause of a disease, any measures to combat it may be hit-or-miss. There can be little doubt that the efficiency of a community is lowered by endemic goiter; consequently the spread of the disease should be prevented."

The first general meeting of the Canadian Association of British Manufacturers and their representatives was held September 8th in Toronto. John Wilson presided, and pointed out that the 55 members of the association represent over 300 British manufacturers. The association hopes to have a representative in London, and that in time it will become as large as the C.M.A. Trade sections of the association were formed, and the chairmen will form a publicity committee. The appointment of tariff and transportation committees are to be looked after by the executive committee. F. W. Field, trade commissioner, reported that the British trade commissioners in Canada have been granted authority by the department of trade and commerce to appoint an expert to deal with all matters of dispute in regard to quality of goods. Capt. John Harris stated that there are in Toronto 250 representatives of British firms.

USEFULNESS OF VEGETATION IN MARITIME ENGINEERING*

By E. T. P. Shewen, M.E.I.C.
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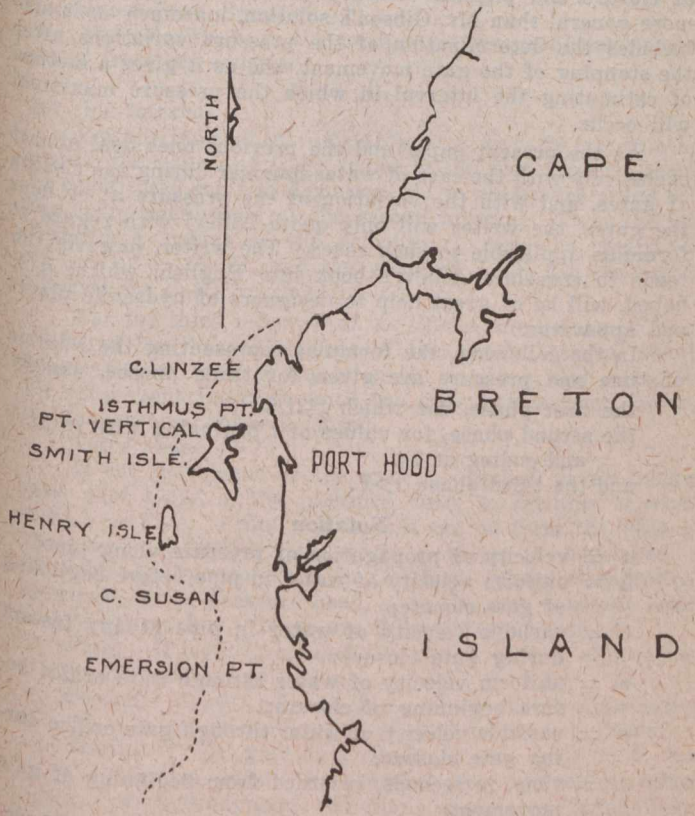
"BRITISH engineers have perhaps been somewhat apt to disregard those transformations which are capable of being brought about by vegetation."

This remark is found in the preface to a book recently published, entitled "Tidal Lands: A Study of Shore Problems" (1918), by A. E. Carey, of London, Eng., and F. W. Oliver, professor of botany in University College, London, Eng.

A convincing illustration of the value of vegetation as a protection against inroads of the sea, was given about ninety years ago in the maritime provinces, by the destruction of a fine harbor at Port Hood, on the west coast of Cape Breton.

Port Hood Harbor

This shelter, 2 miles long and 1¼ miles broad, was formed by the junction with the mainland of Smith's (or Port Hood) Island, which constituted the western barrier, presenting on the east a concave side. From Emersion Point, 4 miles below the harbor, to Dean Shoals, abreast the middle of the island, the coast lies north and south but then trends N.N.W. for 1½ miles to Isthmus Point, there turning due north to Cape Linzee, ½ mile away. At Cape Linzee, the shore swings N.N.E., and continues in that direction almost in a straight line for some miles.



Map Showing Cape Breton Coast Line in the Vicinity of Port Hood

The connection was made by a sand beach, or bar, starting from the shore at Isthmus Point and running nearly ¾ mile S.S.W. to the head of the island.

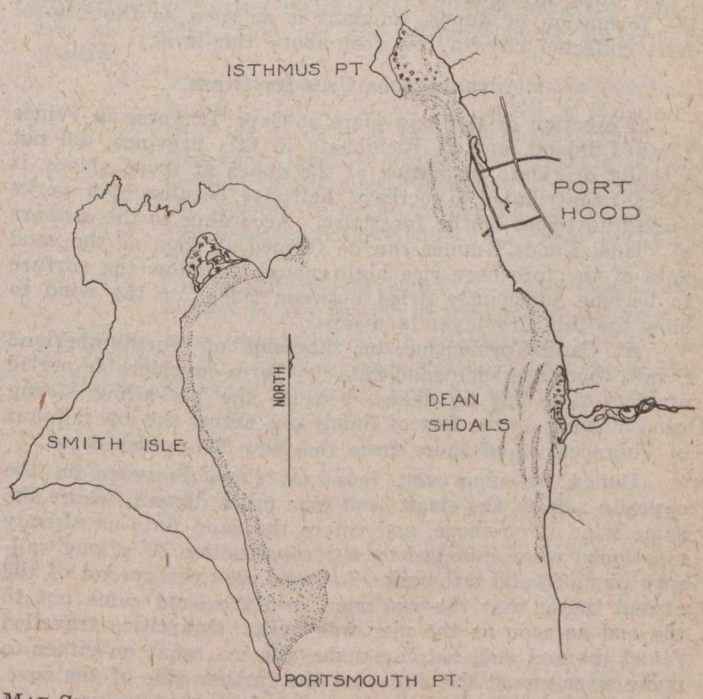
In respect to the littoral drift which made the isthmus, it is worth noting that the line of it, if produced N.N.E., practically coincides with the coast-line for 10 miles from Cape Linzee.

*Paper read at the fifth professional meeting of the Engineering Institute of Canada, September 10th to 12th, 1919, St. John, N.B.

A deep and capacious haven was thus made between the island and the main, large enough to hold a fleet, and affording at best more than seven fathoms of water. Concerning the holding-ground, there is no present information, for the bottom was covered with sand and the depth shoaled when the isthmus was washed away. The harbor was open to the south alone, and in that quarter the fetch is only 21 miles to the Nova Scotian coast. The conditions of a good, natural harbor were therefore fairly fulfilled.

The isthmus was covered with grass, so long, according to statements made a quarter of a century ago by some of the older people of the place, that the children who had to cross to reach the school, used to play hide-and-seek in it on the way.

Unfortunately, cattle were turned out there to graze, and disaster followed. One of the eye-witnesses of the con-



Map Showing Dean Shoals and the Sand Bars That Have Formed in Port Hood Harbor

sequent destruction of the sand beach (and from his apparent age, one of the school-children mentioned), said that he considered the greater damage was done by the hoofs of the cattle in uprooting, and that the actual cropping was a minor evil. In any case, the grass was killed by the cattle, and the sand above high-water, no longer held in place by the roots or protected by the stalks, was blown away by the wind until the crest of the beach, formerly several feet above high water, was soon lowered to that level. A breach, small at first, was shortly after made by the sea.

Isthmus Swept Away

Seeing an opportunity for making a navigable outlet which would save a long sail round the tail of the island in reaching the northern waters, the fishermen enlarged the breach to a size sufficient for a boat-channel. The sea did the rest. Not long afterwards the whole isthmus was swept away, the harbor utterly destroyed, and only an open roadstead left in place of it.

The grass which had preserved the harbor for an unknown period by holding the sand composing the northern bulwark, was evidently a valuable and hardy species, consequently about twenty years ago search was made to find if any of it had survived in some sheltered nook lower down the shore, where the sand and roots must have been carried (part of the sand lodged on Dean Shoals) since the littoral drift follows that direction.

In a cove filled with sand, some distance to the south, grass of the same kind was discovered in quantity, and on being sent to the Experimental Farm for examination, it was

pronounced to be *calamagrostis arenaria*. It was then decided to plant some of it at Negropoint in order to stop the dry sand drift at that time being blown over the top of the work into the harbor of St. John, and also in order to assist the increase of the natural face on the weather side of the breakwater pending its extension to Partridge Island.

Transportation from Cape Breton did not become necessary, for the resemblance of the grass at the head of Courtenay Bay to the Port Hood specimens was observed, and they were found to be identical. Roots were accordingly transplanted from Courtenay Bay to Negropoint, and the desired effect was produced.

On the sandy eastern coast of New Brunswick, and on the shores of Nova Scotia and Prince Edward Island, opportunities occur for the use of this grass, and wherever accumulation of sand is observed to be taking place alongside a new work, it might be prudent, for the purpose of retarding the formation of dunes, to plant it as soon as the littoral drift collected rises a few feet above tide-level.

Advantageous Uses for Grass

If erection of the long piers at Cape Traverse in Prince Edward Island, and at Richibucto in this province, did not actually originate formation of the dunes at those places, it at least contributed to increase their size, because both works caused advances of the foreshore. According to the authors of "Tidal Lands," dunes can be formed as soon as the sand flats of the foreshore rise high enough to allow the surface to become sufficiently dried between tides for the wind to blow the thin dry layer landward.

At Cape Tormentine, on this side of Northumberland Strait, there are wide sand flats dry for a considerable period of each tide, but no dunes, because the prevailing strong wind blowing up the Bay of Fundy and across the low isthmus of Chignecto is off-shore from the New Brunswick coast.

Dunes, are, however, found at Cape Traverse on the opposite side of the strait and nine miles distant, where the same wind is on-shore, and where the sand flats as already mentioned were enlarged by the construction of a long railway pier of solid cribwork So rapid was the spread of the strand there, that the workmen said the sand came out to the end as soon as the pier was built. Quantities travelled round the end and, lodging under the lee, went on either to make or augment the dunes on the farther side of the cove.

At Mabou, ten miles north of Port Hood and on the same coast, dunes have overwhelmed the land, killing the trees and all other vegetation.

The dunes at Richibucto are formed on waste or inferior land, and in consequence have so far caused little damage.

In such places, *calamagrostis arenaria* might be cultivated with advantage. No doubt other varieties of shore plants, useful in greater or less degree for holding or protecting by root or top the dry sand, might be discovered on the shores of these provinces.

The lessons taught by the catastrophe of Port Hood are evidently:—

Lessons Taught by Catastrophe

(1)—To preserve the useful shore grasses, in particular by the exclusion of livestock from beaches.

(2)—To plant *calamagrostis arenaria* betimes, when sand-spits or beaches are being denuded by wind action.

Wherever a breach in the numerous dry sand bars found in this region is being made, after restoring the beach to proper height for survival of the roots, the engineer would act wisely in planting bent-grass.

Movement of the dunes on the European and also on the Australian continents, is being prevented by systematically setting, according to prescribed rules, roots of this grass as a first step, followed by cultivation of other suitable plants as the dunes become fixed.

Botanical investigation of the sandy coasts of Canada, with the view of ascertaining the different kinds of indigenous plants capable of holding sand, which flourish best at varied elevation above high-water (say from 10 ft. to 60 ft.), would furnish information useful to the maritime engineer in hindering the development of sand dunes or in arresting their movement when formed.

PRESSURES IN PENSTOCKS CAUSED BY THE GRADUAL CLOSING OF TURBINE GATES*

By Eugene Halmos
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Ever since the publication of the paper† entitled "Penstock and Surge-Tank Problems" by Minton M. Warren, the writer has hoped that some one would point out the injustice done to one of the greatest hydraulic engineers of the present age by the form of, and the comments appended to, Mr. Warren's presentation of what he termed "Alliévi's formula."

Unfortunately, Mr. Warren has not been corrected. This formula was accepted by American engineers as representing Alliévi's solution of the problem of water-hammer in pipe lines, and, consequently, it has been severely criticized and misinterpreted.

The value of Mr. Gibson's excellent paper is also seriously impaired by the references, both in the text and in the diagrams, to "Alliévi's formula" as taken from Mr. Warren's paper, and the writer would suggest that, after perusal of the following, Mr. Gibson omit all reference to Alliévi, except to state that his solution agrees, in every particular, with that of Alliévi.

The writer proposes to submit a brief summary of Mr. Alliévi's formulas, which, in his judgment, represent a complete solution of water-hammer problems as regards determination of the pressure at the gate or at any other section of the conduit, at any instant, and under any conditions of closure and physical characteristics of the plant. It is more general than Mr. Gibson's solution, inasmuch as it also includes the determination of the pressure variations after the stopping of the gate movement, and as it gives a method of estimating the interval in which the pressure maximum will occur.

As the present paper and the previous ones deal almost exclusively with the case of water-hammer during the closure of gates, and with the variation of the pressure at or near the gates, the writer will only quote Alliévi with regard to formulas applicable to such cases. The writer, however, intends to translate Alliévi's book into English, which, it is hoped, will be of great help to designers of hydraulic plants and apparatus.

In the following, the formulas representing the relation of time and pressure are given for three phases, namely,

the first phase, for which $t \leqq 2L/a$;
the second phase, for values of t beginning with $t=2L/a$ and ending at T;
and the third phase, $t>T$.

Notation

a = velocity of propagation of pressure along pipe;
c_0 = uniform velocity of water in pipe before beginning of gate closure;
C = variable velocity of water in pipe at any instant during gate closure;
u_0 = uniform velocity of water through gate orifice before beginning of closure;
u = variable velocity of water through gate orifice during gate closure;
t = time, in seconds, recorded from beginning of gate movement;
T = duration of gate movement, assumed to be continuous;
L = length of pipe conduit;
y_0 = pressure head on pipe line at gate before closing begins;
y = variable head at gate due to closure.

General Formulas

(1) *Variation of Pressure Head During and After the Closing Motion of the Gates.*—

*Discussion (presented to the American Society of Civil Engineers) of Norman R. Gibson's paper (see September 4th and 11th issues of *The Canadian Engineer*).

†"Transactions," Am. Soc. C.E., Vol. LXXIX, p. 238.

First phase, $t \leqq 2L/a$.

For this interval, the pressure head, y, at any instant can be computed from the equation.

$$y^2 - 2y[H + a^2\psi^2(t)/g] + H^2 = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

in which $H = y_0 + ac_0/g$

and $\psi(t)$ is the ratio of the instantaneous area of discharge to the area of the gate opening at the time, $t = 0$, the value of $\psi(t)$ being taken at the instant for which the pressure head, y, is calculated.

It will be noted that if the gate is closed in a time, $T \leqq 2L/a$, $\psi(T) = 0$, and the equation reduces to

$$y^2 - 2Hy + H^2 = 0$$

$$y = H = y_0 + ac_0/g \quad \ldots\ldots\ldots\ldots\ldots (2)$$

which shows that in such a case the maximum pressure head is independent of the actual length of the time of closure.

Of the two roots of Equation (1) one is greater, the other is smaller, than H. This latter is the true value of the pressure head at any instant.

Second phase, $2L/a \leqq t \leqq T$.

During this period of the gate movement, the following equation applies for the determination of the pressure head at any instant:

$$y^2 - 2y[H - 2f + a^2\psi^2(t)/g] + (H - 2f)^2 = 0 \quad \ldots\ldots\ldots (3)$$

Of the two roots of Equation (3), that giving the smaller value should be used.

It will be noted that this equation differs from Equation (1) only in so far that, instead of H in the latter, $(H - 2f)$ appears in Equation (3).

The values of the function, f, should be determined in the following manner:—

For the interval, $0 < t < 2L/a$, $y - y_0 = F(t)$, y being calculated from Equation (1).

The velocity, C, in the conduit (at the gate) can be computed from the equation

$$y + (a/g)C = H$$

for this interval.

For the interval, $2L/a < t \leqq 4L/a$, $f = F(t - 2L/a)$; in other words, the values of $F(t)$ found in the first interval should be substituted for f in Equation (3) to obtain the value of y for every subdivision of the second interval. Then the corresponding values of the velocity, C, may be found by $y + (a/g)C = H - 2f$, and the value of $F(t)$ for the second interval by $F(t) = (a/g)(c_0 - C) - f$.

For the third interval, $4L/a < t \leqq 6L/a$, the values of $F(t)$ so found for the subdivisions of the second interval should be substituted for f in Equation (3) to get y, and so on, for all subsequent intervals until the gate has stopped moving or has become entirely closed.

Third phase, $t > T$.

If the movement of the gate is stopped at an instant such that $t_1 < 2L/a$, the pressure head, y, remains constant until $t = 2L/a$. From this instant on, or from the time of the stoppage, in the case, $t_1 > 2L/a$, there is developed a hydrodynamic phenomenon in the form of an asymptotical approach of the pressure head, y, to the new constant head, y_0, of uniform flow. There are three different cases.

First.—If $a\psi(t_1) > u_0 + u_1/2$, in which case y approaches y_0 without oscillations.

Second.—If $a\psi(t_1) < u_0 + u_1/2$, in which case y approaches y_0 through oscillations of diminishing amplitude.

Third.—If the gate is entirely closed, $\psi(t_1) = 0$, the pressure head (disregarding the dampening effect of hydrodynamic friction) oscillates indefinitely, with a constant amplitude, between the value of y, which occurs at the instant of closing, and $2y_0 - y_1$, the amplitude being $y_1 - y_0$.

(2) *Estimating the Phase in Which the Maximum Pressure will Occur.*—Assuming a linear closure of the gates:

(a) If $ac_0 < 2gy_0$, then the pressure head at the end of the first phase ($t = 2L/a$) will always be greater than the average maximum pressure [found by Equation (4)] occurring during the second phase.

(b) If $2gy_0 < ac_0 < 3gy_0$, the maximum pressure head occurs either at the end of the first phase, or during the second phase, according to whether the closing time, T, is smaller or greater than $[ac_0 - gy_0)/(ac_0 - 2gy_0)](L/a)$.

(c) If $ac_0 > 3gy$, then the maximum pressure will always occur during the second phase and will be greater than that at the end of the first phase.

Equations (1), (2), and (3) are the general formulas derived by Alliévi, by the help of which complete pressure-time curves can be worked out for any assumed conditions of T, L, a, c_0, and y_0. The writer is very much pleased to state, that, by the use of these equations, he was able to check accurately all the curves presented by Mr. Gibson. He wishes to compliment the author in having found, quite independently, and by a simpler mathematical method than Alliévi's functional derivation, the correct formulas for the representation of pressure-time curves and related phenomena.

Special Formulas

It has been found by experiment, and by working out pressure-time curves for a great number of cases actually met in practice, that, on the assumption of linear gate closure:

(d) The pressure behind the gate remains practically constant for $2L/a < t \leqq T$ (y is not a function of time or $dy/dt = 0$ between these limits) and, therefore, for this period, the pressure is independent of the elastic qualities of the water and the conduit, in other words, independent of (a);

(e) The pressure is distributed in a linear way along the pipe;

(f) The velocity of the water, C, is the same at any instant at any section of the conduit ($dc/dx = 0$).

Taking into consideration the observations noted under (d), (e), and (f), a good average value of y maximum during the second phase can be obtained by solving the equation

$$Z^2 - Z(n^2 + 2) + 1 = 0 \quad \ldots\ldots\ldots\ldots\ldots (4)$$

where $Z = y_{max.}/y_0$ and $n = c_0 L/gTy_0$.

This equation is identical with Equation (C) in Mr. Warren's paper. In order that it should be valid, it is necessary:—

(1) That T be greater than $2L/a$;

(2) That the gate movement (the rate of reduction of the area of the outlet) be a linear function of the time;

(3) That, in case of partial closure, that value of T should be used which would be obtained if the gate should be completely closed at the same rate of speed;

(4) That the physical data, as L, a, y_0, and c_0, shall conform to those ordinarily met in practice.

In order that Equation (4) should produce the maximum pressure head obtaining during the whole movement of the gate, it is necessary that ac_0 shall take the values defined under (b) and (c).

It is evident that Mr. Warren committed a serious error by omitting the publication of Alliévi's general Equations (1), (2), and (3), and by omitting the proper definition of Equation (4) and the limitations of its applicability as defined by Alliévi.

The only ambiguity which may occur in using this formula is the lack of a better definition of Condition (4). This is extremely difficult, on account of the great number of variables entering into the problem. The writer, however, proposes without being able to give strict analytical proof at the present time, that Equation (4) should be used only, if

(α) $Lc_0/gTy_0 < \frac{1}{2}[ac_0/y_0g + y_0/(y_0 + ac_0/g) - 1]^{\frac{1}{2}}$; and,

(β) $ac_0 > 2gy_0$.

As L, c_0, a, and y_0 are dependent on rather unalterable physical conditions, if Condition (β) is satisfied, Condition (α) can be fulfilled by determining T according to the proposed formula.

If, besides Conditions (α) and (β), Conditions (b), (c), (1), and (2) are also fulfilled, Equation (4) will give the absolute maximum head at the gate during the movement of the apparatus.

It will be found that,

for $c_0 \leqq 10$ ft. per sec.

y_0 = between 100 ft. and 500 ft.

$T \leqq 6$ intervals,

all the foregoing conditions are fulfilled, which means that, in most practical cases, Equation (4) actually furnishes the maximum pressure head at the gate.

If the elasticity of the water and the conduit is neglected for the whole time of the movement of the gate, then, for the conditions for which Equation (4) is applicable, the pressure-time curve can be platted from the equation:

$$\log. \{ [(u_0^2+u_R^2)^{\frac{1}{2}}+u-u_R][(u_0^2+u_R^2)^{\frac{1}{2}}-u_0+u_R] \div [(u_0^2+u_R^2)^{\frac{1}{2}}-u+u_R][(u_0^2+u_R^2)^{\frac{1}{2}}+u_0-u_R] \} = [(u_0^2+u_R^2)^{\frac{1}{2}}/u_R] \log. [T/(T-t)] \quad \ldots\ldots\ldots (5)$$

in which $u_R = K(L/T)$, where K is the ratio of the area of the gate opening at $t = 0$ to the area of the pipe, and $u_0 = (2gy_0)^{\frac{1}{2}}$, $u = (2gy)^{\frac{1}{2}}$.

This curve will have a maximum at $t = T$ if Conditions (b) and (c) are fulfilled, and will have a practically horizontal position in the second phase if Condition (a) is observed. It will differ very little from the true curve of pressure variations, and is applicable to practically the whole range of actual water-power problems.

It will be noted that Equations (4) and (5) are identical with Equations (6) and (7) given by R. D. Johnson in his discussion* of Mr. Warren's paper. Great credit is due to Mr. Johnson for having grasped correctly the essential features of this difficult subject, and for his wonderful mathematical skill in solving by independent methods the intricate problem of water-hammer.

In conclusion, the writer wishes to observe, that it would be desirable to encourage the use of Alliévi's, Gibson's, and Johnson's formulas for water-hammer, and to reject and discourage the use of other formulas, some of which, such as Mr. Warren's, are never true, not even accidentally.

*"Transactions," Am. Soc. C.E., Vol. LXXIX, p. 280.

JAPANESE DECISION ON TRADE MARKS

IN a suit instituted by a Philadelphia manufacturing company for the protection of its trade-mark rights, the Supreme Court of Japan has handed down a decision which upholds every essential of trade-mark rights guaranteed under Japan's treaty agreements with the United States and other countries. It places the spirit of the law of Japan on a plane equal to that occupied by western peoples, and it affects, directly and most favorably, manufacturing interests involving annual production on this continent amounting to billions of dollars.

The trade-mark concerned in the litigation is that of the Miller Lock Co., of Philadelphia. This trade-mark (a scroll containing the word "Miller"), was registered in the U. S. Patent Office, October 8th, 1906, and in 36 other countries, date of registration in Japan being March 26th, 1907.

The discovery was made in 1916 that the Crown Lock Co., of Tokyo, Japan, was manufacturing imitations of the Miller padlocks and stamping them with a facsimile scroll containing, in one instance, the word "Crown," and, in another, the word "Million."

Legal proceedings against the infringing company were begun in the Japanese Patent Office at Tokyo, and the fight undertaken with a resolve to end definitely, if possible, all invasions against trade-mark rights, was based upon the weakest aspect of the owners' contention. Instead of alleging infringement by the scroll containing the word "Million," they claimed redress against the infringement committed by means of the scroll containing the word "Crown."

The Miller Lock Co.'s averment, therefore, claimed practically on the scroll alone and risked much by its voluntary choice. But, on the other hand, it put squarely up to the administration of Japanese law and treaty rights the essential principles involved in trade-mark suits and called for a definition of unfair trade competition which must be on a par with the spirit and the administration of the law in the most advanced and just of western countries. In a word, the fight was not one wholly of self-interest; it was undertaken for the benefit of the world's trade and for Japan's welfare no less than that of other countries.

The most distinguished legal talent of Japan was engaged in the struggle, and court and patent office records were searched exhaustively for precedents.

The decision reached is made just as Japanese padlocks, bearing the alleged scroll, are invading Canada.

NEW ENGLAND WATER WORKS ASSOCIATION

FOLLOWING is the program of the thirty-eighth annual convention of the New England Water Works Association, to be held September 30th to October 3rd in Albany, N.Y.:—

"The Operation of and Purification Effected by the New Drifting Sand Filter System at Toronto," by Norman J. Howard, bacteriologist-in-charge, Filtration Plant Laboratory, Toronto.

"Swimming Pool Management," by William P. Mason, professor of chemistry, Rensselaer Polytechnic Institute, Troy, N.Y.

"The Supervision of Public Water Supplies by the New York State Department of Health," by Theodore Horton, chief engineer, New York State Department of Health, Albany, N.Y.

"Schoharie Development of the New York Water Supply," by J. Waldo Smith, chief engineer, Board of Water Supply, New York.

"Water Supplies for the American Expeditionary Forces," by Francis F. Longley, consulting engineer, New York.

"Watershed Leakage," by Robert E. Horton, consulting engineer, Voorheesville, N.Y.

"Hydraulic Fill Dams of the Miami Conservancy District," by H. S. R. McCurdy, division engineer, Miami Conservancy District, Englewood, O.

"The 10-Million Gallon Covered Reservoir of the Dayton Water Works," by Leonard Metcalf and William T. Barnes, consulting engineers, Boston.

"Dangerous Reduction to Insulation Resistance in High Presure Fire Service Motors Due to Moisture," by William W. Brush, deputy chief engineer, Department of Water Supply, Gas and Electricity, New York.

"Detection of Losses from Underground Piping Systems," by Paul Lanham, engineer in charge of waste detection, Washington, D.C.

"Experience in Metering Fire Services," by Frederic E. Beck, chief engineer, Consolidated Water Co., Utica, N.Y.

"Painting Standpipes," by Charles W. Sherman, consulting engineer, Boston.

"Pumping Engines for Small Water Works Plants," by Creed W. Fulton, of the Goulds Mfg. Co., Boston.

"Tests of the Uniflow Pumping Engine," by D. A. Decrow, of the Worthington Pump and Machinery Corporation, New York.

"Guarantees or Assessments for the Extension of Main Pipes," by Bertram Brewer, assistant engineer, State Department of Health, Boston.

A. E. Doucet, director of public works of the city of Montreal, recently recommended to the city council that the claims of Pion & Grothe and of T. Sullivan, formerly contractors for the La Salle Bridge, be settled by returning Mr. Sullivan's deposit of $21,000 and paying him about $6,300 additional, and by returning Pion & Grothe's deposit of $24,000 and paying them about $16,000 additional. Mr. Sullivan's claim was for $56,000 and Pion & Grothe's amounted to over $95,000. This suggested settlement has been rejected by the city councillors, who decided that it did not comply with the Act passed by the Quebec Legislature during the last session, which stipulates that the contractors be paid the value of the work they performed as at the time of performance, together with compensation for all outlays in connection with the contract, these amounts to be calculated without profit to the contractors. The Act stipulated that if a settlement were not made within six months, the city and the contractors were to refer the claims to arbitrators.

THE CASE AGAINST PAYMENT TO CONTRACTORS FOR ESTIMATING

By William Graves Smith
President, Quantity Survey Co., New York

[*General contractors have evidenced considerable interest in the "Nelson Form," the "Kelley System" and other proposed methods of paying contractors for the preparation of estimates. The "Committee on Methods" of the Associated General Contractors of America has requested statements, for purposes of investigation, from the promotors of the various proposed systems of payment, and from W. G. Smith, who is representing the interests of the quantity surveyors. The following is the statement that was recently submitted to the committee by Mr. Smith.*—Editor.]

CONTRACTORS are becoming restless. They are seeking relief from conditions that are recognized as unfavorable, and the very fact of the creation of a national organization shows that they are beginning to reason about the causes of discontent and to study how to improve matters.

One measure of relief proposed is the demand for payment for estimating. Another receiving considerable attention is the introduction of the quantity surveyor to supply uniform quantities as the basis of all bids. Before discussing them it will be well to consider some of the fundamental economic features of construction.

Fundamentals in Construction

It is the building owner who eventually pays for all expense. The overhead expense of architects and contractors, which covers miscellaneous expense of all sorts on projects that do not eventuate in contracts for them, is collected on the jobs for which they do receive contracts. Building owners, therefore, pay indirectly for all estimating and quantity expense.

Again, there should be a sharp distinction drawn between estimating expense and quantity expense. As used in this report, estimating expense will mean the expense of determining labor and material prices and everything else that enters into pricing up quantities of work to be done, except the expense for the preparation of quantities. This is considered as distinct from estimating expense.

Estimating is a part of a contractor's work that by no method can be satisfactorily delegated to any outsider. No method of payment for it can in any way relieve him of the necessity of doing it for himself and for assuming full responsibility for the prices he offers for doing the various kinds of work required under any contract. There is undoubtedly considerable confusion among contractors in discussing payment for estimating due to its close relation to quantity preparation, and by many it is considered as covering both matters. There can be no escape from estimating expense; but there are ways which will be explained to minimize quantity expense in a very desirable and satisfactory manner.

There is a sad misconception or disregard of "overhead" on the part of many contractors. Some say, for example, that estimating expense comes out of "profit." If a contractor does not know what percentage of his receipts goes to pay for rent, insurance, interest, salaries for estimators, etc., or doesn't care to account for these items in his estimates as "overhead," it is a matter for his choice and decision. But if he does not account for his "overhead" as a separate item in his bids, he should not complain if his so-called "profit" is reduced by payment of such items.

Competition vs. Speculation

There must be competition. Anything permitting or leading to the development of a building trust will be disastrous to the interests of the majority. On cost-plus work, even, there should be competition for a percentage contract among acceptable builders, to demonstrate their ability to give service. Service can only be measured ultimately in terms of cost. On the other hand, competition can only exist when uniform requirements are made the basis of competition. Anything else is speculation. Constructive ability and management should be the winning and determining factor. Until they are, and until a generally accepted minimum percentage of profit is demanded by all, the contractor's existence will continue to be a stormy one.

Anything that decreases a contractor's "overhead" or allows him to figure "costs" more accurately, or gives him better opportunity to demonstrate his superior constructive and executive ability, without increasing cost to the building owner, is a good thing for both parties.

Payment for Estimating

Direct payment for estimating would not reduce a contractor's expense for same. His overhead would not be reduced, for a contractor would not be furnished anything that would reduce his labor or lessen his responsibility. It would simply change the method of reimbursement and shift the burden of expense. Contractors that properly treat "overhead" as something separate from "profit" know that they collect in "overhead" all of their estimating expense from the jobs they win. The building owner that gives them a contract pays for the estimating on his own job and on an average for about fifteen or twenty others that his contractor has bid on and lost, or which did not go ahead.

This may seem a hardship to building owners, but looked at from this standpoint, it is not a hardship to contractors. There are, however, many reasons why estimating expense cannot be satisfactorily paid for job by job with any hope of the building owner reaping any benefit financially or otherwise.

In other business, estimating expense or pricing is recovered as an overhead item. Take for example the simple transaction of buying the winter's supply of coal. A coal dealer doesn't charge a separate fee for giving a price for coal delivered at your residence. He has computed the cost to unload and store the coal. He knows what it costs on an average to haul coal within the radius of his district. You don't expect him to figure out a price for you at so much per ton-mile for delivery at your door and to pay him for making the estimate. No; when you ask a price for a definite amount of coal you expect him to name his price. What it costs him to figure a price you are not interested in. If he set an estimating charge you couldn't tell whether it was fair or not. You wouldn't care to be bothered with separate payments and wouldn't expect that it would result in any economy to you if the coal dealers adopted such a practice.

This example of the coal transaction should point out an important difference in the contracting business. Quantity data is furnished to the coal dealer and he names his price. In contracting, bidders have been doing both the quantity work and the pricing or estimating work. The coal dealer assumes no responsibility as to the amount of coal required. It is your responsibility to order enough to keep you warm during the winter. Contractors, however, have been assuming responsibility for all their quantity work when making bids.

Objections to "Payment"

There are many obstacles in the way of collecting estimating expense job by job. Who is going to determine the proper estimating fee for various classes and sizes of jobs? A uniform rate would not apply to all jobs or to all contractors.

Who is going to pay the fee? the owner, or the architect, or will it be collected and paid through a broker acting for the bidders? If paid by the owner or architect, he will expect all bidders to meet the lowest fee accepted by any bidder. Contractors intent on bidding won't hesitate to bid on that account. They will add the difference to their bids if the fee paid seems too small. That would put matters back where they are now. If collected and paid through a broker acting for the bidders, unless the sanction of the architect and owner is obtained, an injustice is done the owner. If the owner must pay he should know to whom he is paying estimating fees and how many. He will be interested to know what it is costing him.

How are the sub-contractors to receive separate payment for their estimating expense? If it is good for the general contractor, it ought to be extended to the "subs." If a fee

large enough to reimburse the "subs" is paid to the general contractor, what assurance is there that it will be fairly divided among the "subs"? On the other hand might not the "subs" victimize the general contractor by collecting their full allowance from each and all of the general contractors to whom they tendered a bid for any job?

What effect would it have on competition? It would stifle competition. An owner would choose to pay for a minimum number of estimates. It would foster formation of a building trust which could be applied to for all estimates. That, it is useless to say, would not benefit the majority of contractors.

"Bidding" for the Payment

How would an architect or owner know what group of contractors to pay for estimates? They know that some contractors will consider their job attractive and be really desirous of competing for it, but how can they know whom they are? Any contractor, with very little labor, can name a price that would guarantee a fine profit, and some might be tempted to do so if paid $200 or $500 or more for the few hours' labor required to make the estimate. But will that satisfy a building owner or an architect? Is it good business?

If competition is kept open, what will prevent anyone from going into the business of making estimates based on cubage, or some other short-cut method, and collecting the estimating fee?

Contractors would continually know of jobs that they would like to bid upon, but had not been offered an estimating charge for doing so. Do you think that would stop them from bidding, or would stop an architect or owner from considering their bids if they were responsible parties? Most certainly not; and if an owner could get good bids without separate payment for estimating expense, do you think he will pay for others that would be no better?

The contradictory situation would arise where a contractor who wanted to figure a job would beg for the opportunity and at the same time demand to be paid for the privilege.

Quantity Expense Real Factor

True estimating expense, separated and not confused with quantity expense, is a small matter. It is better left as an item of overhead. Estimating cannot be delegated to an outsider. It is too personal, and comprehends the assumption of risks and responsibility based on experience and judgment. Consequently, leave it in overhead, along with rent, interest, bad bills, etc. There is no more reason for separating estimating on buildings than there is to separate the coal dealer's estimating expense from the price of a ton of coal.

It is true that contractors cannot, under prevailing methods, give a price for a building as simply as a dealer can for coal. He must find out what is going into a building. That involves the matter of quantity expense and the risks carried therewith. An analysis of that part of a contractor's work will develop the real reason for the demand and agitation for relief, and will dispel some of the confusion that exists.

The liquidator of the defunct Rock and Power Machinery Ltd. has made his final report, in which he announces that $11,767 has been paid on secured and preferred claims, but that there will be no dividend whatever for ordinary creditors. The principal asset available for ordinary creditors was a contract with the Kennedy Engineering Co., he states, but as the creditors declined to furnish the necessary funds for litigation, the claim was abandoned.

The executive committee of the American Association of Engineers has rendered a decision that the constitution of the association does not prohibit the admission of architects, and announces that the applications of architects will now be considered as having the same status as applications from engineers. Those architects who have previously applied for membership and whose applications could not be accepted on account of the apparent exclusion of architects by the constitution, may re-enter their applications for membership.

HIGHWAYS TO LOWER THE HIGH COST OF LIVING

By John S. Beall
President, Armco Iron Culvert & Flume Manufacturers' Association

To say that unimproved roads increase the cost of living is to give a reason without a remedy. Economists are raising their voices against waste and mismanagement, both of which undoubtedly add to the fast-mounting cost of everything we eat and wear. To-day, we hear that blame should be placed upon the middleman; yesterday the effect of the world war was proclaimed the reason for high prices; to-morrow we will hear that the high cost of everything is due to some other single cause. But in my opinion, the high cost of living to-day is due to a combination of causes, no one of which is altogether to blame.

When we consider that following every great war, with its necessarily vast destruction of property and slowing up of production, prices rise and the cost of living consequently increases beyond the income of the average person, we must look behind the alleged causes which are to-day said to be making prices high, and get down to the fundamental causes which made living higher than it should have been before the great social and economic disturbance which resulted from the world conflict. In other words, we must find out what made living as high as it was before 1914.

Trucks Compete with Railroads

People never kick about the price of a thing if they can afford to buy it. It is only when the price of a commodity rises beyond the amount of money they can afford to pay for that commodity that we hear cries of profiteering and witness social unrest, such as is sweeping the country to-day.

The last fifty years have seen the growth of huge cities in the central west and west, and a consequent concentration of population in these cities. Where eggs were six cents a dozen fifty years ago, they now cost fifty-six cents. Where they were eaten fresh from the barnyard fifty years ago, they are to-day transported to cities, placed in cold storage and later, months later, sold to the consumer when he has fifty-six cents which he can afford to devote to the purchase of this food. The farmer who once "drove to town" with his load of eggs, has now been pushed, by the growth of cities, many miles from the city markets and depends upon the railroads to carry his product to where he can receive a high enough price to allow him to carry on his farming business and supply himself and his family with the necessities of life—necessities he cannot himself produce, if he is to maintain his farm at its maximum production.

Just as the railroad seemed to make the farmer independent of the highway, so is the motor truck developing to make the producer of foodstuffs independent of the railroad. The railroad, however, is an organization owning the rolling stock and tracks over which the cars are operated, while the motor-truck owner is often an independent unit, operating over a road controlled by the money of every road bond-buyer and taxpayer in his community, and the communities through which he must pass if he transports his product by motor truck to market.

Municipal Markets

It has been said that the cost of food has *not* been greatly lowered in eastern cities, where farmers, either single or co-operating, transport their products by truck from farm to market. This is true where the farmer sells to the wholesaler, and the wholesaler sells to the retailer who, in turn, sells to the customer, who is the ultimate consumer. By this method only the high freight and express rates of the railroad are eliminated, and these are replaced by the cost of motor transport.

But where municipal retail markets have been established, the cost of food products has been materially lowered. The farmer drives in with his produce and sells direct to the consumer. Many cities are developing these municipal markets, where those who cannot afford to pay the high prices charged by the retailer, and made necessary by the number

of hands through which the products pass, can purchase on the cash and carry plan.

The recent seizures of food products, under the war-time food laws, has turned the attention of the public toward cold-storage methods. The food hoarder is threatened with jail; the food controller or "packer" is being condemned, and drastic laws are being advocated to regulate monopoly and the withholding of products from the market by storing them.

Until production gets back to normal, and supply and demand are to some extent regulated by the completion of the reconstruction period through which we are now passing, we cannot hope for greatly lowered prices. But we can turn our minds to-day toward the construction of the necessary works which the present high prices and unstable conditions have made us realize played a big part in bringing about the situation which now confronts us. Governments, states and provinces have realized this, and we see evidence of their activity in the great, road-building plans now in operation or under consideration, the vast amount of money set aside for road construction purposes, and the active advocation of suitable legislation to bring about nation-wide systems of improved highways.

Proposed Federal Control

Conspicuous among the highway legislation now before the United States congress, is a bill pending in the senate which was introduced by Senator Townsend, chairman of the Committee on Post Offices and Post Roads. It is proposed in this measure to create a vast system of highways under federal control and maintenance. This system will embrace not less than 2%, or more than 5% of the mileage in actual use in each state.

What will such a system, when completed, mean to the people? For one thing which is fundamental—yet which has been long neglected and never properly considered—it will bring our food-producing areas nearer to our manufacturing centres. This means that the vast numbers of people engaged in manufacturing will, with proper legislation designed to bring about the condition, pay less for the food they eat and for everything that is produced by nature to feed the wheels of industry.

Saves Middleman's Profits

The man who lives on the highway and produces food products along the highway, will benefit by highway improvement chiefly because (if he transports his product direct to the consumer in the city via the municipal market or direct to the home), he will have the benefit of the profit now paid to the railroad company, the middleman, the cold storage plant and the retailer. In this way the farmer can get much more for his products than he receives at the present time and still sell them to the public at a lower price.

From this brief survey it is clear that the improvement of roads should be the concern of every person, whether he be laborer, farmer, merchant, banker, doctor, lawyer or otherwise, living either in the city or in the country.

The improvement of highways is a definite, fundamental step toward decreasing the high cost of living. It is something which needs no investigation to prove necessary. Let us put our shoulder to the wheel and roll the mud holes into better roads.

The Winnipeg Aqueduct Construction Co. has agreed to settle all claims against the Greater Winnipeg Water District upon the understanding that the district will pay $2,339 rebate on freight charges. Claims amounting to over $100,000 have thereby been dropped by the company.

The "Committee on Development" of the American Institute of Electrical Engineers has recommended that there be inaugurated the custom of periodically holding an engineering congress, the delegates to which should be selected from all parts of the United States under a plan to be devised for suitable representation, this congress to consider and take action on such matters of general interest to engineers and the public as may merit its attention and as have been previously advertised for a sufficient length of time to permit local organizations of engineers to consider them and to send instructed delegates.

SIGNIFICANCE OF CRACKS IN REINFORCED CONCRETE CONSTRUCTION*

By Stanley H. Harris

CRACKS frequently occur in reinforced concrete structures as in every other form of masonry construction. These cracks are generally due to one or more of the following five causes: (1) Cracking due to contraction of concrete in setting; (2) cracking due to expansion and contraction, caused by temperature changes in the concrete; (3) cracking due to too early removal of forms; (4) cracking due to overloading of the structure; (5) cracking due to settlement of supports.

When concrete sets in air it has a tendency to shrink or contract, and the richer in cement the concrete is, the greater the tendency to shrinkage and cracking. The shrinkage varies from 0.15% to 0.2% of the length for neat cement, and from 0.03% to 0.05% for concrete poor in cement. Although the strength of concrete increases with the amount of cement in it, too much cement, on the other hand, will cause frequent contraction cracks, which tend to neutralize any gain in tensile strength due to extra cement. This is a point which should be borne in mind when designing structures to hold water or other liquids. In these structures all the tensile stresses should be taken by the steel, and it is of the greatest importance to have a concrete which is dense and not liable to contraction cracking. A 1:2:4 concrete, made of properly-graded materials, will be sufficiently strong and dense for most tank work, and is likely to develop less contraction cracks than a richer mix.

Minor Temperature Cracks Unimportant

Cracking frequently occurs through expansion and contraction, due to temperature changes, especially in those parts of the structure which are exposed to the sun and weather, such as roofs and external walls. A great deal of this cracking can be minimized by the adequate provision of temperature steel, but within limits a certain number of minor temperature cracks are inevitable, and should be recognized as inevitable. They are unsightly, perhaps, but as a rule do not affect the strength of the structure.

Removal of forms too soon, produces cracks in floors and weak spots in walls. In the case of floors, if the forms are removed too soon slight settlement occurs, and the soffits of beams and the slabs develop fine hair cracks. In the case of walls there may be no visible sign of any injury, but they often divide at places in their thickness, which may be ascertained by tapping them with a piece of wood or metal, when the hollow sound produced is evidence of the result. Cracking due to this cause should never occur if the job is properly supervised.

Causes of Serious Cracks

Overloading of the structure or considerable settlement of supports produces the most serious cracks; in fact, they are usually the only kind of cracks of any considerable moment occurring in concrete structures. Cracks due to this cause usually occur as fractures in columns or as diagonal fractures in main or secondary beams. If such cracks occur, steps should be taken to remove the load and to strengthen the members affected. Sudden failure is not likely to occur immediately on the appearance of such cracks, as beams and columns generally will carry a lot more load after the first appearance of cracks, before final failure takes place. The appearance of these cracks, however, is often an indication that the member is overstrained.

In estimating the significance of cracks, some attention might profitably be given to what we might call "the eye of the observer." A mere hair crack in the eye of one observer is a chasm in the eye of his neighbor. It might truly be said that nature abhors an uncracked structure almost as much as she abhors a vacuum. No building has yet been devised by the mind of man and erected with his hands which does not have cracks, but their appearance in

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*From the proceedings of the Royal Victorian Institute of Architects.

a reinforced concrete structure often arouses a quite unnatural malignity in the mind of some observers towards this long-suffering material. The philosophical reason for this would appear to be that a concrete surface invites the eye to hope for an unbroken plane, and then some untoward and unknown cause intervenes to produces a crack, and the eye and mind feel themselves tricked. All structures, even of the most monumental marble or masonry, have cracks equally with concrete; but, whereas reinforced concrete is monolithic and jointless in its character, all other constructions in masonry or marble are discontinuous and jointed. The result is this—that the cracks produced by movement in an ordinary jointed structure are dissipated, and spread over the innumerable beds and joints of the construction, but in a concrete structure they are apt, unless the steel reinforcement is sufficient and properly disposed, to concentrate themselves in well-defined and sometimes ugly openings. Very slight movements in the foundations of a reinforced concrete structure will often produce cracks which in appearance are out of all proportion to their significance. Such cracks, as a rule, do not affect in the slightest degree the stability of the structure, and are no greater in their totality than the numerous smaller cracks to be found in the joints of any brick or stone structure.

In a properly designed and constructed reinforced concrete structure there should never be serious cracks in the main structural members, and where there are no such cracks in these members, any cracks in the slabs supported by them are generally quite trivial, from the point of view of structural significance. Much worry would be saved by many architects and engineers if this were recognized and frankly accepted. Anyone promising to erect a large concrete structure which shall not have shrinkage and temperature cracks, merely engenders hopes which rarely come to flower. However, a great deal can be done to minimize these cracks in floor slabs by providing sufficient steel over the supports to resist the negative bending movements and by providing sufficient steel to counteract temperature and shrinkage effects.

An Australian Case

As an example of a large reinforced concrete structure containing big masses of concrete exposed to the sun and weather, we might mention the reinforced concrete dome over the Melbourne Library. At the time of its construction, in 1909, it was the biggest reinforced concrete dome in the world, the inscribed diameter being 115 ft., and the circumscribed diameter, 126 ft.

The detailed design of the reinforced-concrete dome over the Melbourne Library was prepared by the Trussed Concrete Steel Co., of England, to the requirements of the architects, Bates, Peebles & Smart, and the reinforcement, in the form of Kahn rib and Kahn trussed bars, was sent out from England all ready for fixing in the work.

In constructing the Melbourne dome, one complete rib on each side of the lantern ring was concreted in one day, together with part of the roof slab on each side of the dome ribs. The remainder of the roof slabs and purlins was filled in some days after the completion of the main ribs, as it was found impracticable to complete the concreting in one continuous operation. The result of this was that the concrete in the ribs had set fairly hard and contracted before the concrete in some of the roof slabs was poured, so that when this latter concrete set and contracted, it pulled away slightly from the flanges of the ribs in spite of steel placed in the flanges of the ribs and concreted into the roof slab with the idea of preventing it. Some years after completion of the dome the junction of the roof slab and flange of the dome rib was visible, showing in a distinct crack. The appearance of these cracks, running parallel with the reinforcement in the roof slab, does not affect the stability of the dome in the slightest degree.

The dome is octagonal in plan, and consists of eight angle ribs, and eight intermediate ribs restrained at the top by the lantern ring, and at the base by a continuous band of steel running around the top of the brick octagon which supports it. The dome is designed to be completely stable between the limits of the bottom ring of steel and the lantern ring, but for the sake of appearance, and also to add some extra stiffening to the ribs, they are continued past the bottom tension ring, across the flat annular roof, running around the dome in the form of deep concrete abutments. The abutments have an arched opening through them, and in each arch small cracks have developed, being most marked at the angle buttresses. These cracks are not as big as cracks often seen in brick railway arches carrying main-line traffic, and appear to be due to the combined effect of shrinkage and temperature both in the concrete and in the brick octagon underneath the dome, which is 114 ft. high to the springing of the dome. As the part of the dome in which these cracks appear is merely ornamental, they have no influence on the stability of the structure. In addition to these cracks, slight cracks have appeared in the ring around the base of the dome. The concrete ring, containing the continuous steel band, is a great mass of concrete having a cross-sectional area of about 20 sq. ft. From the nature of concrete it stands to reason that some cracking must occur in such a large ring, due to contraction and temperature effects. Since the thrusts from the rib are taken by the steel band contained in the concrete ring running around the base of the dome, the small amount of contraction and temperature cracking in the concrete ring cannot affect the stability of the dome as long as the adhesion of the concrete to the steel is not impaired.

A structure such as this, exposed to all the effects of wind, weather and temperature, must of necessity move or breathe under their action, and it would have been against the nature of things if no cracks had occurred.

Cracks Foreseen by Designers

At the corner ribs the thrust is transferred to the main tension ring by means of steel stirrups made of ¾-in. square steel-rib bars. It was at first thought that some of the cracking in the concrete work was due to these members not acting efficiently. It was therefore decided to construct a model of this part of the dome, one-sixth full size, and test it to destruction. The results of this test showed that not only did these members transmit the load efficiently, but actually strangled themselves in their efforts to transmit the loads. The stresses in the concrete and steel of the main members, taking into account temperature effects, were also investigated, and were found to be very low. The cracking, therefore, was found to be almost entirely due to the effects of contraction and variations of temperature, and that such cracking would occur was foreseen by the designers of the dome, and pointed out before construction was begin.

Where big concrete structures of this sort, exposed to the weather and temperature variations, are built, it is always advisable to place a false ceiling under the structure rather than plaster the ceiling directly on to the concrete work. Breathing movements must occur in such structures, and then the ceiling may crack and bits fall off, unless a false ceiling is provided.

United States Engineering Council has addressed a letter to the president of the United States urging that a board of surveys and maps be appointed, consisting of a representative from each of the present United States map-making agencies, together with representatives from well qualified map-using agencies, and that this board be invested with authority to devise a plan of standardization and co-ordination of the map work of the United States government and report same to the president for such action as he may find wise. Engineering Council states that at present the United States Geological Survey is the principle map-making agency of the United States government, but there are many other agencies of that government employed in similar work. Engineering Council states that a complete topographical map of the country would be very useful in the location of railways and highways; plans and location of drainage and water supply projects; prosecution of geological, soil and forest surveys; development of water powers; installation of electrical power lines; construction and maintenance of inland waterways; location of reservoir sites for flood prevention and water conservation; etc.

WATER DEPARTMENTS AND PRIVATE FIRE LINES*

Proper Regulations Governing Private Fire Protection Lines —Suggestions for Compensation—Contamination of Water Supply—References to Court Decisions

By Dow R. Gwinn
Terre Haute, Ind.

In considering fire protection, there should be no confusion between that which is furnished by the municipality, known as public fire protection, and that which is for the exclusive use of all individual or manufacturing concerns. In the first case, the pipes and hydrants are on public streets, while in the second case large pipes are laid into private grounds and buildings to which are connected fire hydrants, automatic sprinklers, and stand pipes. The manufacturer who desires something more than the public fire protection should, of course, pay for private protection of a special character. A comparison could be made with the public police protection furnished by the municipality and that of a manufacturer paying for a private watchman or police. The municipality provides fire and police protection of a general character for the public. If special protection of a private character is desired, the cost is met by those who enjoy the special privileges. It is not necessary in every case to connect with the city water mains to enjoy private fire protection.

Protection by Independent Plants

This protection can be provided by means of independent or local equipment, such as fire pumps and elevated tanks. A number of manufacturing concerns now provide their own special fire protection in this way and in such cases they pay the actual cost of the same. This cost includes interest on the investment, depreciation, repairs, taxes, fuel used in maintaining steam, extra labor in looking after fire pumps, and also additional labor on Sundays, holidays and at such times as the factory may be shut down. It has been estimated by an insurance expert that the cost of such special private fire protection when furnished by the manufacturer would amount, in one particular case, to approximately $600 per annum.

Special Connections With Mains

This service is furnished in cases where the manufacturer does not wish to make the investment for fire pumps, etc., and to employ men to keep up steam on holidays, Sundays and such times as the factory may be shut down. Connections with public water supply should not be made with private pumping plants having other sources of supplies than that furnished to the general public. Typhoid fever epidemics have resulted in several cities on account of private fire lines being connected with the public water supply and also with contaminated sources through private fire lines. In the city of Lowell, Mass., I understand there were about 25 deaths; in Auburn, N.Y., there was a small epidemic; in Rockford, Ill., there were 40 deaths, although it is said that it was not clearly proven that the fire line connection was to blame. It is reported that typhoid fever epidemics have been caused by fire pumps draughting from polluted sources and seeping through leaky check valves into public mains at Sheboygan, Wis., and Morris, Ill. The public health is of such great importance and human life is so precious that no connections should be made between the public water supply by means of private fire lines and other sources of supply.

Where connections are made with a public water supply for private fire protection, there is a menace to the remainder of the city on account of danger of broken sprinkler pipes; there are a number of cases on record where the automatic sprinklers have failed to control the fire and falling walls have broken the large supply pipes, making it impossible for the water works to maintain adequate fire pressure. With a 6-inch supply pipe discharging a full stream, it would be practically impossible for the average water works plant furnishing water under direct pressure to supply adequate fire protection for a second fire in case one should break out at that time. The result of a broken sprinkler pipe might mean a serious conflagration and destruction of a large portion of the city.

It is the opinion of the author that insurance companies will realize this menace before many years have passed and will discourage if not prohibit large connections between the water mains and automatic sprinklers. At the present time, the Committee on Fire Protection of the National Board of Fire Underwriters recommend in congested valued districts, a supply of 7,500 gallons per minute in excess of the domestic consumption and state that this includes an allowance for loss from broken services, elevator, and sprinkler connections incidental to a large fire. This means that in order to provide fire protection which is considered adequate by the underwriters, it is necessary for the water department or company to provide equipment and mains sufficient to take care of a demand on account of broken sprinkler connections. This means an extra investment or cost to the water department or company. If such connections are furnished, the water department or company should receive just and reasonable compensation for such special service.

There should be no question in regard to the right to furnish this service by meter measurement and there should be no connections allowed unless the same are provided with meters. The meters for this purpose should, of course, be subject to the approval of the water department or company. In most cases, they should be meters which have been specially designed for fire lines, although there are cases where a compound meter would be satisfactory.

Suggestions for Compensation

(1) On the basis of the saved insurance premiums. These savings due to automatic sprinklers amount, in some cases, from $1,800 to $3,000 per annum. If the water department or company furnishes the service by which reductions in insurance rates are made, the compensation should be adequate. The reduction in insurance rates on account of automatic sprinklers in one particular case was from $1.60 per hundred to 20 cents.

(2) The compensation should be equal to the cost to the consumer if such special fire service was furnished independently. This will, of course, include interest on investment, repairs, taxes, fuel, extra labor, etc.

(3) Compensation to the water department or company on account of large mains, additional equipment, etc., necessary to provide adequate service to the manufacturer, and also for maintaining pressure and standing guard over premises of the manufacturer; under this arrangement, there should be a minimum meter rate on the basis of the size of the meter, in proportion to the minimum rates charged for ordinary house meters. Where the water department is standing by, maintaining pressure on the premises of the manufacturer, the compensation should be adequate for such unusual and valuable service.

Rules for Private Installations

1. All private fire protection services will be installed by the company, which will ascertain the best location for same, and lay the pipe from the street main to a point just inside the wall of the building, or within the building line of open yards, where buildings are set back from the building line. The consumer will be charged for time and material, plus 10 per cent.

Size of Service Pipe

2. In all cases, the company shall decide the size of the service pipe. In all cases where underwriters' pumps are to be installed, a suction pipe of sufficient internal area to deliver a quantity of water equal to the full rated capacity of the pipe will be allowed, and no enlargement of said suction pipe inside of the premises will be permitted. If, however, this service pipe is run to a surge tank placed in

*Excerpts from paper read before twelfth annual meeting of the Indiana Sanitary and Water Supply Association.

close proximity to the pump, the full size of suction which the pump calls for may be run from the pump to the tank.

3. One service only will be allowed to any one building or premises, unless in the opinion of the company, the general or public fire protection will not be jeopardized and more than one is absolutely necessary for the proper protection of the premises. All fire equipment connected to the company's service shall be confined within the building or on the premises named in the application, and where two or more connections are made for one building or premises, they shall be kept separated, unless special permission is obtained from the company to connect the same in a manner to be approved by it.

Test of Fire Services

4. Whenever a fire service system is to be tested under the regulations of the fire insurance underwriters, the consumer must notify the company of such proposed test, naming the day and hour when the same is intended to be made, so that, if desired, the company may have an inspector present during the test.

Contamination of Water Supply

5. Any fire protection system supplied with water from the company's service shall be supplied exclusively with such water, and no connection will be allowed with any other system drawing its supply from any other source whereby the company's water supply may be contaminated by the failure to close valves, or leaking check valves, etc., and no auxiliary or secondary suction pipe to any underwriters' pump taking water from wells, streams, or other source whatever, will be permitted. Any fire protection system using water from wells, streams, or other source than the company's service shall be kept separate from any such system supplied from the company's service.

Inspection

6. All fire services shall be subject to inspection by the company from time to time, and the consumer shall give the inspectors all reasonable facilities for making the inspections, and any information concerning the same that the inspector or the company may require. Care will always be taken that inspections will be made with as little inconvenience to the consumer or occupant as possible.

Approval of Fire Chief

7. All applications for private fire protection shall be subject to the written approval of the chief of the fire department of the city, who in such approval, shall state that, in his opinion, the public fire protection will not be endangered by the connection proposed to be made by the company, when properly safeguarded by the placing of an indicator post valve as near the main as possible, said valve to be under the control and orders of the chief of fire department at time of fires, with full authority to close said valve.

Guarantees

8. The company or department in no manner guarantees to furnish a proper quantity of water through fire protection services, nor does it undertake to guarantee anything relative to such service, but it will endeavor to maintain the efficiency of its service under all conditions. The granting of a permit for private fire protection is under the express condition that the company shall not be considered or deemed in any manner to have undertaken to extinguish fire or to protect any person or property against loss or damage by fire or otherwise, the said company not being an insurer of persons or property, and that it shall be free and exempt from any and all claims for damages on account of any injury to persons or property by reason of fire, water, failure to supply water or pressure, or for any other cause whatsoever, and that in the event of the destruction of the premises of the consumer, then the contract between the company and the consumer shall immediately cease.

Plans and Drawings

9. The consumer will furnish an accurate sketch showing the pipes, valves, hydrants, connections, and appurtenances on the premises of the consumer and connected with the mains of the company and also an accurate sketch of any other water pipe system and fixtures that may exist on the premises.

Excerpts from Court Decision

"The principal object of the defendant's water board in requiring fire service pipes to be metered is to prevent the surreptitious or careless withdrawal of water through such pipes for other purposes than the extinguishment of fires; another object is to procure the measurement by meter of all water consumed for any purpose in order to check wastage and to require each taker to pay for the exact quantity of water furnished to him. . . .

"Both upon principle and authority we are of opinion that under circumstances like those before us it is not unreasonable to require the installation of a meter at the plaintiff's own expense in its private fire service pipes.

"Nor can it be said that this regulation imposes undue burden upon the plaintiff. The defendant has afforded reasonable means of extinguishing fires by public hydrants; if the plaintiff desires in addition a private system for the protection of its own buildings, it is not unfair for the defendant to impose, as a condition of supplying without other charge water to make this system available, the requirement that the plaintiff shall take this water only through a meter to be put in at the plaintiff's expense." Shaw Stocking Company vs. City of Lowell. (Supreme Judicial Court of Massachusetts; Middlesex, May 2nd, 1908. 85 Northeastern Reporter, 90.)

Public Service Commission's Ruling

"These authorities are cited to show the views of courts of high authority, and for the further reason that they are in harmony with the conviction of all men who have thought seriously upon this subject. There is no perceptible reason why the water company should be compelled to provide and maintain a sufficient supply of water to operate the water sprinklers in time of fire for private individuals, without compensation. On the contrary, this special benefit to the property owner over and above what the municipal fire protection affords the people in common, should be paid by the private user." Indiana Public Service Commission in the case of Commercial Club of Terre Haute, vs. Terre Haute Water Works Company, decided December 18th, 1915.

"The proprietor of a building, who installed therein an automatic sprinkler system, intending thereby to put out fires before they could gain headway, derives benefit from the system in fire protection and reduced insurance rates, and though there be a general benefit in reducing fire hazards, yet a municipal water works system to which the sprinkler is attached performs a service, and stands ready to perform others for which charges may be made.

"It is evident that payment for the small quantity of water used would be wholly inadequate as compensation for the pressure required, and the readiness at all times to serve and the inspection by the city which might well be exacted." Edgerly vs. City of Ottumwa, 156 N. W. 388, decided February, 1916, by the Supreme Court of Iowa.

Action to restrain city from placing a meter on fire extinguishing plant dismissed by Appellate Division of the Supreme Court. Judgment affirmed with costs. American Manufacturing Co., Appellant vs. City of New York. Court of Appeals of N.Y., January 27th, 1911.

Entitled to Reasonable Compensation

"A water company which supplies the pressure and water for an automatic sprinkler for a private corporation performs a service which is not included under its contract with the city to supply water for fire protection and has the right to make a reasonable charge therefore against the corporation." D. B. Loveman Co. vs. City Water Co. 1 Tenn. Ch. App. 596.

"In the matter of furnishing water to its citizens, a city when authorized by its charter acts in a private rather than a governmental capacity and has the same right to make reasonable charges therefore that a private corpora-

tion has when serving the public." St. Louis Brewing Association vs. City of St. Louis, 140 Mo. 419—37 S. W. 525. 41 S. W. 911.

"A rule providing that water meters might be installed at the pleasure of the water board on the consumer and that after they had once been installed, the consumer could not thereafter return to the flat rate is reasonable and may be enforced where the meter rates are reasonable and no discrimination between consumers is shown." Powell vs. Duluth. 97 N. W. 450.

"The law imposes no duty to insure the property or extinguish fires." Woodberry vs. Tampa Water Co. 57 Fla. 243, 49, So. 556.

The Arizona Commission in fixing rates to be paid to a water company, decided that a mining company desiring a private fire protection system, should be required to pay a fixed demand charge although "the actual water consumed for this purpose is likely to be negligible." Arizona Corp. Com. vs. Morenci Water Co., Public Utilities Reports, 1915, C. 525, 527.

SOME LESSONS AND PROBLEMS*

By F. W. Bricknell
City Engineer, Hull, Eng.

IT may be useful to consider in what way and to what extent the war has left its mark on municipal work.

All the usual services have, of course, been badly hit by the scarcity of labor and material, so much so that, locally at any rate, prices have hardly needed to be considered.

Taking these services in detail, highway maintenance has probably called for the most criticism from the general public. Here the necessity for deferring repairs far beyond ordinary practice has given an opportunity for verifying pre-war opinions.

There was nothing left to learn about granite-sett paving, and scarcely any repairs have been necessary during the war.

Paving Experiences

In regard to wood paving, there has been more cause than ever to regret the extensive adoption of Australian wood, and it could almost be said that the paving with Petrograd redwood has caused no anxiety at all, and will require comparatively little attention before the Australian wood is replaced. About 160 standards of Petrograd deal, purchased in 1915, served for urgent replacements until the middle of 1918, and since that time English oak and larch have been used; but, wherever possible, the old blocks have been turned and relaid on a "soft bed." English larch offers considerable promise as a paving wood. It takes creosote unevenly, and some has been laid without creosoting, but that now in use is being creosoted by the Rueping process. The oak used is, of course, not from long planks, but from "offcuts" and billets.

The Trinidad asphalt paving, referred to in the writer's 1916 paper, has given general satisfaction, and this paving, now known as "Lithocrete," has been selected for the streets to be paved under the "Road and Bridge Program, 1919-20." There were special and local reasons for preferring this paving to the less expensive two-coat work.

Many macadam roads have become less comfortable for cyclists, but none have caused serious complaints. The situation has, in fact, been saved by tar-spraying, and the writer sees no reason to change the opinion he expressed in 1916 that, except where heavy rubber-tired traffic has to be carried, water-bound whinstone macadam, tar-sprayed annually, is far preferable to tar-macadam.

Welding Tramway Rails

The tramways have fully justified the ideas of their designer, the late Mr. White; but rails which have been eighteen to twenty years under traffic are naturally showing wear at the joints. Up to 1916 it had been the practice to pack up a hammered joint until the lowest part was at normal level and then to dress off the projecting portion. This would, of course, eventually have destroyed the rail head, and in 1916 acetylene welding was adopted. In 1918 acetylene supplies were so difficult to obtain that an arc welding set was purchased, and although this involves night work, it seems likely to supersede acetylene, as, so far as can be judged at present, the results are more permanent.

The value of the close anchorage of the rails is very plainly seen now that some of the holding-down bolts have given way. At such places a pumping action is set up with more or less subsidence of the rail.

Of new developments during the war it is only necessary to mention food production and national kitchens.

Allotments and War Gardens

While every possible effort was made to obtain additional allotments, it was necessary to accommodate about 1,850 applicants on war plots. With one or two unimportant exceptions the owners of the land gave every encouragement, and no rent was paid by the corporation except for land already earning rent. For the most part the plots were let off in batches to a "principal tenant," who paid an acknowledgment of one shilling. In most cases the tenants did all their own work, but in some cases fencing, drainage, etc., was done and an additional rent charged.

The difficulty with regard to allotments proper was that all suitable land was regarded as ripe for building, and the owners would not tie it up for a period of years. It was found, however, that tenants were quite willing to take the risk of disturbance for building, and a number of leases were entered into for periods up to ten years, with a provision that the owner may resume possession at short notice for *bonâ-fide* building development without payment of compensation. After a time an officious person discovered that tenants could not contract out of the Act, and since that time no further land has been taken. The total area leased during the war was about 170 acres, let off to about 2,176 tenants. The rent paid by the corporation varies from £2 10s. to £5 per acre, and after paying for fencing, drainage, road-making and water supply, it is necesary to charge rents varying from 10s. to 12s. 6d. for a plot of $\frac{1}{16}$ acre.

Every possible assistance has been given to occupiers in the way of free literature, lectures and advice, the supply of manures and lime at wholesale prices, and the spraying of potatoes at less than cost.

National Kitchens

While it is to be hoped that no lesson is required for the future, it is probable that existing national kitchens have a long life before them, and there is no doubt that in many districts their catering offers a welcome relief from the intolerably bad private catering.

The principal point of interest about the Hull kitchens is the policy which was pursued of taking over existing shops which were finding a difficulty in obtaining supplies and installing the tenants as managers. Generally speaking the arrangement has been a great success, one branch in particular yielding very large profits. The policy fell short of obtaining the best results because, on the one hand, it was not fully developed before the need was past, and not enough branches were opened to keep the central kitchen fully occupned; on the other hand, the branches needed a supply of confectionery and sundries to keep them occupied for the full day, and it was only after considerable delay that a bakery was rented and set to work for this purpose. The committee has, however, every reason to congratulate itself on the success of its policy, and it is all to the good that when times become normal their managers will be able to resume their old businesses with improved premises, wider custom, and some useful lessons.

Turning to the future, there are three sets of problems which are exercising the minds of most municipal engineers. The most conspicuous of these is, of course, housing, as to which the writer does not feel himself in a position to speak, as his connection with it is confined to the construction of streets and sewers. Here it is necessary to face those problems of routine work which are concerned with giving the ratepayer satisfactory services at not too great an increase

*Paper read before the Institution of Municipal and County Engineers, July 26th, 1919, in Hull, England.

on the old prices, and the means of doing so will be discussed later. Meanwhile, the writer would emphasize the importance of making each scheme part of a town-planning scheme, and avoiding the isolation which has been the bane of private estate work in the past.

Next, and probably the most attractive subject, is the flood of new works which has been held up by the war, all of which works have earnest advocates, each of whom is anxious that his pet scheme shall have preference over all others. If a small proportion of the Hull schemes materialize the writer will have an interesting time, and there will be good material for another visit of the institution. It remains to be seen how far the financial condition of the country will allow the schemes to materialize.

Use of Machinery

The third problem, and that to which I wish to direct the special attention of members, is that of bringing the cost of routine work and also that of street and sewer construction to such a figure as can be covered by a not intolerable increase of the rates. With average weekly wages doubled, cost of materials more than doubled, and assessments stationary, it is difficult to see how the doubling of rates can be avoided, and it might be said that the ratepayer has no right to expect it, but he is at any rate entitled to an effort.

The first cost to be attacked is that of labor. The old class of navvy and horseman, who was recruited from the country, has almost disappeared from the towns, and most of those who are in the towns can find easier and better-paid employment than that offered by a municipal body. The townsman has an inferior capacity for heavy work and a very strong prejudice against it. The obvious policy, therefore, is by some means to cut out the heavy work and endevor to staff public works with men who will use their heads. A simple example is the use of scarifiers to break up macadam roads. Formerly these were not used in Hull because they would displace labor. Now they have to be used, because pick-work is unpopular. If all increase of costs could be met as easily as this there would be no scope for a discussion.

Problems in Mechanical Loading

In view of the urgency of housing work and the shortage of navvies, the writer has looked into the question of using trenching machines for the sewer and gas, etc., trenches in the new streets. At the time of writing the economy of such a machine for the amount of work required at Hull is doubtful. One cannot propertly adopt the usual practice of debiting the work with a percentage for interest and depreciation, but must charge the whole cost of the machine to the rush of work for which it is purchased. Before this paper is read no doubt some additional light will be thrown by Mr. Collins' paper at the general meeting.

A much simpler proposition is a tamping machine. The first cost is comparatively small, and not only should there be a saving in working expenses, but there should be an efficiency which was lamentably wanting in hand-work.

The loading of vehicles is work which cries out loudly for mechanical assistance. Costly vehicles are kept standing when they might be running, and good horsemen and motormen are lost because, being good, they can obtain work in connection with mills, etc., where they do not have to handle their loads. The writer has been able to obtain the use of high-level coal cells, and to obtain delivery of a certain amount of road metal and fuel in hopper wagons, which is an admirable solution so far as it goes. Some material landed at wharves by crane can be taken direct to its destination, but there remains a great deal which has to be picked up in the yard and elsewhere. There are some inexpensive mechanical loaders which deal well with dry macadam, gravel, etc.; but tarred material is a problem, and destructor clinker is even more unpopular with the man, and there is more of it. The average cost per ton is probably four times what it was ten years ago.

Improved Road Surfaces

In street cleansing most engineers, no doubt, find that they are already reaping the benefit of past work in improving road surfaces and in tar-spraying. Where a reasonably hard stone has been used, even an untreated water-bound macadam road which has been repaired several times by steam rolling, has a much lower dirt-producing capacity than the old roads of the writer's early days. The partial disappearance of the horse has effected some relief, and for about fifty weeks in the year the only scope for economy seems to lie in substituting single-handed work for gang work in all but the principal streets. During the dirty weather in late winter good use can be made of a picking-up machine, but it must be an inexpensive machine which can be attached to another vehicle. The writer has used Whittome's machine with satisfaction for some years.

Most engineers probably have to continue to use the motive power already at their disposal. In a fairly level town, and for miscellaneous work, there is not a great deal to choose between various types, and the capital cost of mechanical vehicles is a deterrent to their use at the present time. Given plenty of heavy work and suitable loading facilities, steam is by far the most economical. During the war, when the writer was hard pressed for both horse and mechanical drivers, an electric rully was ordered with the idea of employing a man of the navvy type to drive it. A permit was obtained after the armistice, but at the time of writing the rully is not delivered.

Economies in Material

The writer would like to elicit opinions as to economies in material. Most towns have their particular extravagances and parsimonies. In Hull natural flags have benerally been used. There seems to be no justification for continuing to buy them when highly satisfactory artificial flags can be laid at half the price. Wood-paving blocks, where large areas have to be relaid, might be reduced in depth to 3 ins. There are purposes for which concrete can replace other materials, but with cement at the present price the number of purposes is reduced.

The cost of refuse destruction has for long been somewhat of a bugbear to the writer. During the war not only has the cost of wages more than doubled, but the character of the refuse has changed, its calorific value having become almost *nil*, and the so-called clinker increased to about 50 per cent. of the original weight.

In the interest of allotment-holders the corporation was allowed to establish an experimental pulverizing plant which had been held over from the outbreak of war. It is too early to give financial results, but it is safe to say that the cost of treatment is less than burning, and there is no clinker problem; but the small plant dealing with about one-fifth of the refuse easily supplies the present demand for the manure. Such a plant really should be a destructor, as a great deal of large stuff has to be thrown out, especially during "spring cleaning," and has to be destroyed by other means.

If the demand for the manure increases the writer proposes to install a screen at one of the destructors and screen out the small stuff for manure, in the expectation that he will thus get rid of a great deal of the inert matter and obtain better furnace results from the remainder. Meanwhile, he is encouraging the health department, who collect the refuse, to dispose of as much as possible by tipping, and he has no hesitation in defending the practice.

Established Services Severely Treated

It is not to be hoped that any alterations of practice will bring expenditure appreciably nearer its old level, but it is a usual experience that councils handle the estimates for established services much more severely than those for new schemes and new departments. In the hope that the exchange of ideas will enable members to maintain the efficiency of their works in spite of this tendency, the writer has put together his notes with the feeling that their value depends on the extent to which they elicit the ideas of othe

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Approximately 1,200 houses have been built this year or are now being erected in Ontario under the provisions of the Act granting loans to home-builders. In Ottawa, 120 houses, valued at more than $400,000, are under construction; in Oshawa, 34 houses; in Windsor, 65 houses; and similar renewed activity is being indicated in many other cities.

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PRINCIPAL CONTENTS

TORONTO'S SEWAGE DISPOSAL PROBLEM

IN the article on performance of the slow-sand filters at Toronto, which appeared last week in *The Canadian Engineer*, Norman J. Howard, bacteriologist in charge of the filtration plant laboratory, shows that the pollution of Toronto's raw-water supply has increased approximately 62% within the past five years, judging by B. coli tests. Of the 300 days in which examination of the raw water was made during the year 1918, the typical colon-bacillus was present in one cubic centimetre on 121 days.

The continual deterioration of the raw water at Toronto is due to the increase in discharge of sewage into the lake. While this applies not only to Toronto but also to many other neighboring municipalities which are daily discharging large quantities of sewage into the lake, the absence of proper sewage disposal works at Toronto is undoubtedly responsible in a very large degree for the increased pollution. The Morley Avenue sewage disposal plant, which has never operated to the satisfaction of either the municipal authorities or the public, is now reaching the limit of its capacity for even such work as it is doing, and it is said that within a few months it will have exhausted the areas at its disposal for the deposit of sludge.

As the late Theodore Roosevelt remarked several years ago in Buffalo, the people of Canada and the United States should be sufficiently civilized to be able to get rid of their sewage in some other manner than by dumping it into their drinking water.

Toronto, like many other cities, is faced with a sewage disposal problem that may cost a large sum of money before a satisfactory solution is found, but it will be money well spent, for no money can be spent to better advantage than in the improvement of public health, and there is no phase of sanitary work that is of more importance than the protection of water supplies.

Fortunately for Toronto and many other cities, the liquid chlorine plant which was installed a few years ago has proven extremely efficient. That chlorinating plant is the only thing that stands between Toronto and a great increase in the typhoid death rate. The amount of raw sewage that is being poured into the lake, comparatively near the water supply intake, is so polluted with matter of excremental origin that the water could never be filtered so efficiently as to render it entirely innocuous. Moreover, the filtration of such heavily polluted water would cost an enormous sum for coagulant if Toronto's drifting sand filter plant had to be operated every day in the year, and every hour in the day, to the highest possible efficiency. In order to reduce the expense for coagulant, the plant is now being operated, it is said, at a lower efficiency than the filters are capable of showing, and the chlorinating apparatus is being relied upon to sterilize the water, as it has been proven by months of experience that the chlorine treatment ensures sterile water even when the filters are being used only to cleanse the water.

The high efficiency of the chlorine plant, however, does not excuse Toronto from a solution of the sewage disposal problem. It is far safer to prevent pollution of water supplies than to remedy the pollution. There will come a day when the load upon the Toronto filtration and sterilizing plants will be extremely serious unless active measures are taken to solve the sewage disposal problem. The works department of the city of Toronto realizes this, as the works commissioner has been requesting the city council for the past two or three years to authorize the expenditure of $50,000 for sewage disposal experiments, but some of the other civic officials and some of the city councillors have not so thoroughly realized the urgent need for action. Nevertheless it is understood that the department intends at an early date to send an engineer to Milwaukee to reside there for several months in order to study the activated sludge method of sewage disposal in co-operation with T. Chalkley Hatton as consulting engineer; and also that the department intends to experiment with a new English centrifuge for dewatering sewage sludge. It has also been said that Dr. Nasmith, director of laboratories of the health department of Toronto, has under investigation a very promising method of sludge disposal, and his work is being watched with interest by the other Toronto civic officials.

WATER WORKS MONTHLY REPORTS

AS a part of its system of control of water purification plants in Wisconsin, the Board of Health of that state recently issued a report form which must be filled out and returned monthly by the superintendent or operator of every water purification system within the board's jurisdiction.

The form requires a statement of the number of gallons of water pumped, pounds of liquid chlorine or "hypo" used per twenty-four hours, P.P.M. of chlorine used, free chlorine in treated water, bacteria count in raw and treated water at 20 and 37 deg. C., and the B. coil count in raw and treated water in 1cc. and 10cc. This information must be given for every day of the month; also the number of filters used each day, the hours of service of each filter (length of run), the average filtration rate, the loss of head (initial and final) on each filter, the number of washes and number of minutes per wash, the amount of water used for washing, the amount of alum used in pounds and in grains per gallon, the turbidity in P.P.M. in the raw water and in the effluent of each filter, and the alkalinities of the raw and clear water.

If the board can persuade all plants, both large and small, to make a complete return of this information for every day in the year, it will certainly have a valuable record of water supply conditions in that state, but we fear that in connection with the reports from small plants there will be either many blanks or frequent guesses. However, it is the intention of the board to conduct an efficiency run of every plant at least once a year, and that will assist greatly in checking the reports.

PERSONALS

DR. GEORGE G. NASMITH, who will be one of the three partners in the newly-formed consulting firm, Gore, Nasmith & Storrie, Toronto, was born December 31st, 1877, in Toronto, Ont. He attended the Wellesley public school and in 1896 graduated from the "Old Grammar School," now the Jarvis Collegiate Institute, and enrolled at the University of Toronto in the natural science course, specializing in geology, chemistry and mineralogy. From 1900 to 1902, he took a post-graduate course in science and physiological chemistry, obtaining the Ph. D. and M.A. degrees. In 1902, Dr. Nasmith joined the Ontario Board of Health as a chemist under Dr. Amyot, and during the following eight years wrote a number of papers on chemical research, including several articles on coal-gas poisoning and water sterilization. A paper upon the latter subject was published in the Royal Army Medical Journal and the method described was later adopted in many places throughout the world. In 1910, Dr. Nasmith became director of laboratories for the health department of the city of Toronto, from which position he is now resigning, the resignation to take effect at the end of the current year. Dr. Nasmith recommended chlorination of the water supply of the city of Toronto at the time of the break in the intake in 1911, and lowered the typhoid death rate from 42 to 20 per 100,000 (which figure has since been reduced to the present rate of approximately 2 per 100,000). It is largely to Dr. Nasmith that credit is due for the elimination of excess water from Toronto's milk supply, saving about $600,000 during the past few years for the people of Toronto. He is the inventor of the brush trickling filter for sewage disposal plants, and is now working upon a solution of the sewage sludge problem. In 1914 Dr. Nasmith went to Valcartier as head of the Hydrological Corps, in charge of water supply, and was requested by Gen. Sir Sam Hughes to go overseas as sanitary adviser to the first Canadian expeditionary force. Dr. Nasmith originated the portable filtration and sterilization unit which was adopted by the British War Office, and was sent to France with the rank of colonel, in charge of the Canadian Mobile Laboratories attached to the First British Army. At the second battle of Ypres he discovered that the gas being used by the enemy was chlorine. He promptly found an antidote and devised a gas mask. For these and other services, on New Year's Day, 1916, he was invested with the Companionship of St. Michael and St. George. Upon his return to Canada, he received the honorary degree of D. Sc. in 1917, and last year he passed the examinations at the University of Toronto for the degree of D.P.H. (Doctor of Public Health).

LT.-COL. A. E. DUBUC, D.S.O., has been appointed by the Department of Railways and Canals, Ottawa, as superintending engineer for the Province of Quebec, to succeed the late Ernest Marceau.

PAUL E. MERCIER, consulting engineer to the city of Montreal, has resigned. Mr. Mercier was appointed deputy chief engineer of the city of Montreal in 1914, and in January, 1916, chief engineer. In May, 1918, he became director of public works, from which position he retired last November to act as consulting engineer to the civic departments.

WILFRED HOLLINGWORTH, of the contracting firm of Brennan & Hollingworth, Hamilton, Ont., has sold his interests in that firm to his partner, W. C. Brennan, and has returned to England. Mr. Hollingworth came to Canada from England several years ago, and for a time was assistant city engineer of Hamilton.

MAJ. L. E. SILCOX is now on the engineering staff of the C.N.R., locating the line west of Bengough, Sask. In 1914 Major Silcox was locating engineer of the Hudson Bay Railway. He and twelve men who were working with him enlisted for overseas service. Seven of them won decorations for gallantry, Major Silcox being awarded the D.S.O., and one was killed.

L. N. EDWARDS, who resigned a few months ago as supervising engineer of bridges, Department of Works, Toronto, in order to accept a position as senior highway bridge engineer with the Bureau of Public Roads, Washington, D.C., has been transferred to Fort Worth, Texas, and will be district engineer in charge of the bureau's bridge work in Mississippi, Arkansas, Oklahoma and Texas.

ELMER LUNDERVILLE, comptroller of the Canadian Ingersoll-Rand Co., Ltd., Sherbrooke, Que., has resigned and has purchased the munition-manufacturing plant of the Norwood Engineering Co. at Cowansville, Que., where he will make a number of engineering specialties after he has equipped the plant with some new machinery. Mr. Lunderville joined the Ingersoll-Rand sales staff about twelve years ago, and was subsequently the firm's purchasing agent for several years.

W. F. V. ATKINSON, chief forester of the Spanish River Pulp & Paper Mills, Ltd., is entering private practice at Sault Ste. Marie, Ont. He will continue his connection with the Spanish River Pulp & Paper Mills, Ltd., in a consulting capacity, and intends also to conduct investigations of natural resources for any other companies who may desire his services in establishing new industries dealing with timber lands and water powers. He will specialize in forest engineering, including water storage and conservation.

TOWN PLANNING INSTITUTE OF CANADA

WITH the co-operation of the Commission of Conservation of Canada, a joint meeting of the American City Planning Institute and the Town Planning Institute of Canada will be held October 17th and 18th at the Chateau Laurier, Ottawa.

The secretary of the congress is Flavel Shurtleff, 19 Congress St., Boston. The assistant secretaries are M. J. Patton, 30 Rideau St., Ottawa; and F. D. Henderson, Topographical Surveys, Ottawa.

The congress will be opened at 2 p.m., October 17th, by addresses of welcome by Hon. N. W. Rowell and Mayor Fisher, of Ottawa. These addresses will be followed by a report of the committee on the fundamental principles of city planning (Frederick Law Olmsted, chairman); a report of the committee on street widths (B. A. Haldeman, chairman); and discussion. After an informal dinner the report of the committee on zoning (Mr. Bassett, chairman) will be presented, followed by discussion.

At. 9.30 a.m., Saturday, October 18th, Morris Knowles will present the report of his committee on the economic design of utilities in streets, and Arthur B. Comey of the committee on lot sub-division. At noon the delegates will be the guests of the Canadian Club at luncheon. The speaker will be C. H. Mitchell, dean of the Faculty of Engineering, University of Toronto, whose subject will be "Reconstruction and Town Planning." In the afternoon the town planners will visit the Parliament Buildings and drive around the city and parks. In the evening Thomas Adams, chairman of the Town Planning Institute of Canada, will present a paper on "Practical Housing," illustrated by moving pictures; and Noulan Cauchon, chairman of the Ottawa branch of the Town Planning Institute of Canada, will read a paper on "The Planning of Ottawa."