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MISSING

The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

DIONIC TESTER IN WATERWORKS SERVICE

Portable Apparatus Permits of Quick and Easy Determination of Source of Suspected Flows Where the Municipal Water Supply is of Markedly Different Conductivity than the Ground Water—Relation Between Conductivity and Bacteriological Purity

By JOSEPH RACE

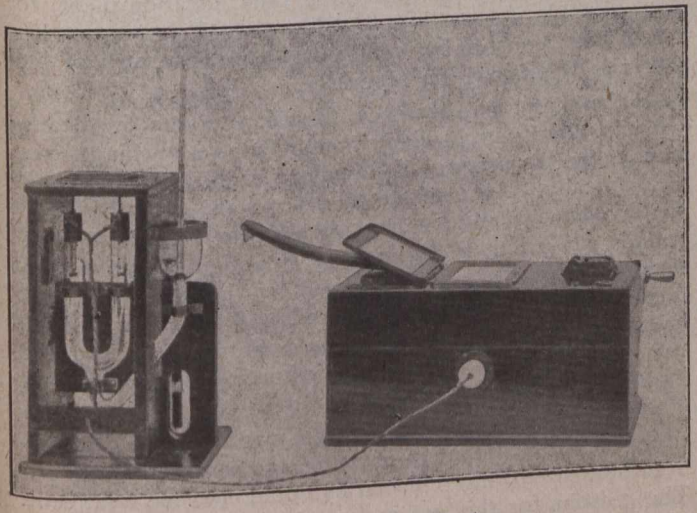
City Bacteriologist and Chemist, Ottawa, Ont.

ORIGINALLY, the Dionic water-tester, a portable apparatus designed for the determination of the electrical conductivity of water, was devised as a rapid and reliable method for detecting leakages of cooling water into surface condensers.

It was later suggested that it could be used for the detection of sewage pollution in water, but experimental work has shown that except in cases of gross pollution, the conductivity method is of little value. There are other purposes, however, for which the apparatus has been found to be of considerable value in the writer's laboratory, viz., the detection of leakages from mains; the estimation of mineral matter in natural waters; and the examination of distilled water.

Detection of Leakages from Water Mains

It is often desirable to determine the character of water in order to ascertain whether it is due to leakage from a water main or service, or is derived from a spring or other natural source. For this purpose the conductivity method will be found to be of great assistance when the conductivity of the public supply is materially less than that of the natural waters. The conductivity of the Ottawa supply is usually about 50 units, a unit

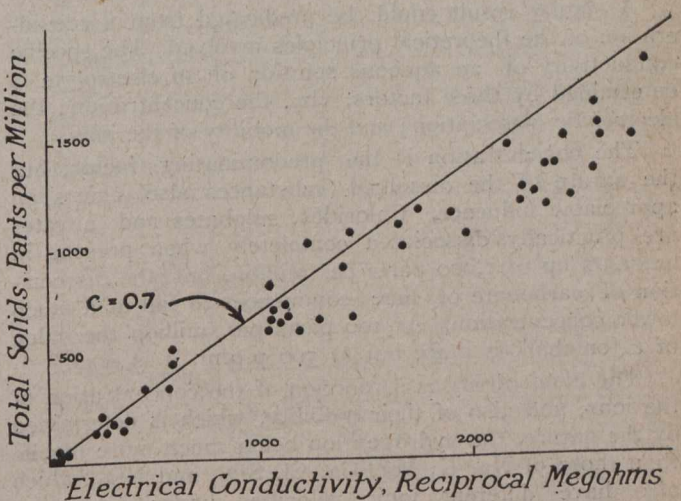


The Dionic Water Tester

being one reciprocal megohm, and it has been found that ground and spring waters never give a value of less than 200 units. The difference, 150 units, is so large that there is no danger of mistaking one source for the other.

This test, which requires only a very short time for completion, has been applied in Ottawa for several years with marked success, and has detected leakages which aggregate over one million gallons per day. In other cases, where water was suspected to be due to leakages, the test has shown it to be ground water and has saved the cost of exploratory digging.

One typical example of the detection of leakages might be cited. A stream of water issued from the face



of a hill for many years, and was always thought to be ground water finding its way from one of the many fissures of the limestone strata. A sample was tested in the conductivity apparatus and was reported as tap water. The stream was followed up and was found to be due to a leakage amounting to 300,000 gallons per day from a water main.

The only ambiguous results that have been encountered were caused by leakages travelling considerable distances and dissolving sufficient salts from the sub-soil to increase appreciably the electrical conductivity. Such cases have been very small in number and do not seriously detract from the value of the method.

The Dionic water-tester is by no means to be regarded as a substitute for pitometer or aquaphone surveys, but as a complement to them. Leakages that escape to drains and fissures, and which do not appear again, can be found only by the pitometer or aquaphone. But any visible water that cannot be accounted for should be tested for conductivity and its source established.

Estimation of Mineral Matter in Water

The electrical conductivity of water is caused by the presence of ionized salts in solution, and, as the great majority of the salts present in natural waters are com-

pletely ionized, the conductivity method has been proposed as a rapid way of estimating the inorganic solids. Certain German sanitarians who have experimented with this process, have stated that the mineral matter is directly proportional to the conductivity, and found that the factor c was approximately 0.7. The factor $c = m/e$, m being the mineral matter in parts per million, and e being the electrical conductivity in reciprocal megohms.

The writer has determined the value of c for a number of surface and subsurface waters of the Ottawa district, and some of the results are plotted in the accompanying diagram. A number of the results have not been plotted because they would have crowded the sketch too much in one spot. Most of these were of the Ottawa River at various stages and are so close together that there seemed to be no object in plotting them, considering the purpose of the diagram. A few other results not plotted were of saline waters which gave results far outside the limits of the diagram. These saline waters are extreme cases which are very rarely encountered.

It will be seen that c is by no means constant, and although the average of seventy determinations gave a value of 0.65, the variations from the mean are very considerable and invalidate the accuracy of the process as an indirect one for estimating the mineral content of water.

A similar result could be predicated from a consideration of the theoretical principles involved. The specific conductivity of an aqueous solution of an electrolyte is determined by three factors, viz., the concentration; the electrolytic dissociation; and the mobility of the ions.

The concentration is the predominating factor, but the nature of the dissolved substances also exerts an appreciable influence. Chlorides, sulphates and nitrates are practically dissociated completely when present in amounts up to 1,000 parts per million, but the dissociation of carbonate of lime commences to fall at a much lower concentration. At 100 parts per million the value of c for chalk is 0.40, but at 500 p.p.m. it is 0.47.

The conductivity is a function of the concentration of the ions, and also of their mobility, which is determined by the nature, the hydrogen ion being much more mobile than those of Na, K, Mg, Ca, Cl, SO_3, and NO_3, which also have different ionic velocities under a constant potential gradient.

The conductivity results are of value, however, in the classification of the source of supply, and frequent examinations of well waters have shown that there is often a correlation between the bacteriological purity and changes in the electrical conductivity. Deep wells, of great purity, have given a remarkably constant conductivity, whilst wells showing intermittent pollution have given varying conductivities. One well in Ottawa yields a water of good quality when the conductivity is about 2,000 units, and shows excessive pollution at 200 units. These results point to contamination with surface water, which gains access through a faulty casing pipe.

Wells yielding two different classes of water have been noted. One well, when the consumption is normal, supplies a chalk water having a conductivity of about 700 units; when the draft is very heavy, a saline water with a conductivity of 20,000 to 25,000 units is obtained.

Examination of Distilled Water

As absolutely pure distilled water is a very poor conductor of electricity, the conductivity method is very suitable for its examination. By employing special precautions, distilled water can be prepared having a conduction of less than one unit, but the ordinary product made in laboratories will be found to have a conductivity of from three to five units. After storage in soft glass bottles, the value is usually much higher, and conductivities of thirty and over in samples obtained from pharmacists do not necessarily indicate inferior methods of preparation. A value of six should be regarded as the maximum for freshly-prepared distilled water, and if higher values are obtained, the still should be carefully examined for leakages.

CHLORINATION*

By Charles A. Jennings, Assoc.M.Am.Soc.C.E.
Formerly Sanitary Engineer, Union Stock Yards, Chicago

LESS than ten years ago hypochlorite of lime was used for the first time on a large scale for the disinfection of a water supply. Previous to that it had been used in large quantities to prevent the spread of typhoid fever from polluted water supplies, but no attempt had been made to so treat a polluted water that disease-producing organisms would be eliminated and yet the water would remain unchanged in taste and odor.

In these ten years, the use of chlorine compounds in sanitary science has grown tremendously. As would be expected, because of such a rapid growth, the use of these substances has come into bad repute in some instances. Sometimes this has been due to the fact that over-zealous people expected more of the treatment than could be accomplished, and sometimes it has been because water companies or departments attempted to accomplish with chlorine compounds, work which called for clarification in conjunction with disinfection. Things have adjusted themselves very satisfactorily by this time and filtration has its place, decolorization its place, iron removal its place, chlorination its place, and so on. Some problems require for solution a combination of several methods of purification.

It was in 1908 that the epoch-making work was done at the Bubbly Creek filtration plant at the Chicago Union Stock Yards by Geo. A. Johnson, using hypochlorite of lime, in conjunction with a rapid sand filtration plant, to make potable a grossly polluted water. Previous to this it had been considered sufficient to remove 97% of the bacteria by purification processes.

Since that time, however, filtration plants in nearly every instance use chlorine compounds as a finishing treatment. By the process of filtration, bacteria are removed mechanically. An average of 97% to 98% of the total bacteria can be removed by this process. Chlorine compounds are used as a finishing treatment because they seemingly have a selective action for the organisms that cause disease. The quantities required are very small. Every new filtration plant that is modern will be found to be equipped with a liquid chlorine apparatus for sterilizing the filtered water.

Whereas hypochlorite of lime was formerly used entirely for the disinfection of water and sewage, now it has been almost entirely replaced by liquid chlorine treatment. The reasons for this are many. Hypochlorite of lime, or "hypo," is a loose compound of lime and chlorine gas; in other words, the lime serves as a carrier for the chlorine gas. Moisture and carbonic acid in the air cause this loose compound to deteriorate by giving off chlorine. Shipment is made in wood and sheet iron drums, which

*Paper read at annual convention of the Southwestern Waterworks Association, April, 1918.

are likely to disintegrate. The strength of the hypo decreases rapidly upon exposure to the air. There is considerable loss to the material by being weighed out and being made up into a solution, and there is a great deal of undesirable nuisance connected with this operation. Accurate readings must be made of the amount of solution being applied. Orifices and solution feed lines clog up with undissolved material in the solution.

Advantages of Liquid Chlorine

Liquid chlorine, or compressed chlorine gas, is shipped in steel cylinders holding 100 or 150 lbs. each. These are similar in appearance and construction to ammonia, oxygen and carbonic acid cylinders. At room temperature the pressure on a full cylinder of chlorine is about 90 lbs. Being under pressure, there is no loss in the strength of the substance. In order to liquefy the gas, it is necessary to rid it of its impurities and so it will average over 99.8% pure chlorine as used from the cylinders. In the use of liquid chlorine for the disinfection of water and sewage it has been found that the ratio between the amount of hypo to the amount of chlorine to accomplish similar results is about 6:1, with a minimum of 3:1 and a maximum of 10:1.

These ratios depend upon the strength of the hypochlorite in the solid form, upon the care with which a solution is made of the hypo in the water and upon the care with which the solution is applied to the water. The ease of operation, especially the direct reading of the amount of sterilizing agent being used, lends itself to more accurate control and more consistent results than could be obtained by the use of hypochlorite. Tastes and odors are seldom met with in supplies treated with liquid chlorine. Milwaukee, Wis., effected a saving of $2,200 in one year on labor alone by the use of liquid chlorine instead of hypochlorite. An appreciable saving was effected also in the chemicals used in favor of liquid chlorine. Minneapolis, Minn., saved $1,800 the first year of operation with liquid chlorine instead of hypochlorite, all of which saving was in the cost of the chemicals. In addition to this there was a saving in labor. The average cost of disinfection with liquid chlorine during 1917 was 37 cents per million gallons. In more than two years, there have been no complaints of tastes and odors resulting from this treatment.

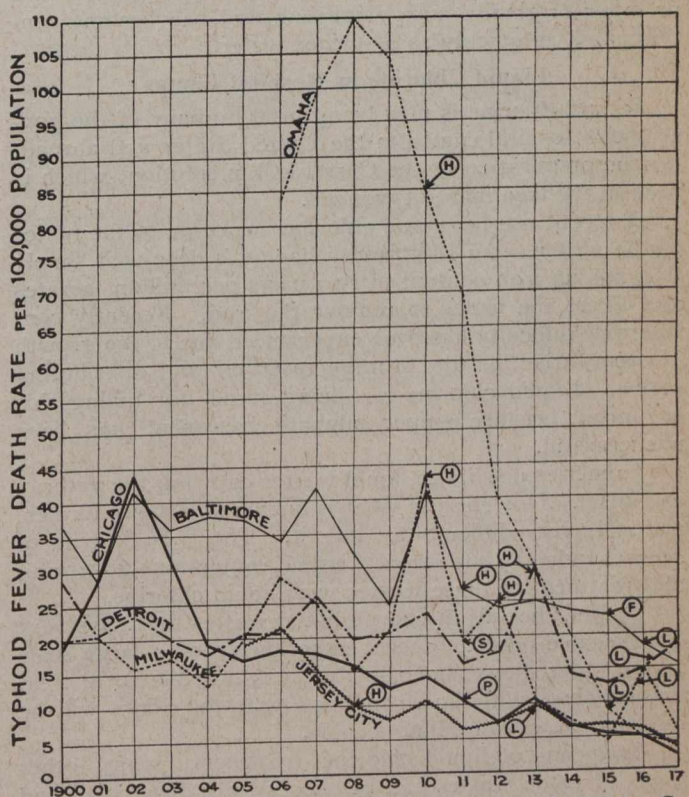
At the present time there are probably 1,200 cities in this country using chlorine compounds for the disinfection of water and sewage. Of these, possibly 300 are still using hypo and the others are using liquid chlorine.

Prejudice Has Almost Disappeared

The former prejudice against "doping the water supply" with a "foul-smelling chemical," has almost died out. This has come about through the successful treatment of water supplies, in most instances, without any production of odors or tastes, through the wonderful reduction in the typhoid fever death rates, and through the winning over of the health officers and other members of the medical profession to an understanding of what this treatment could and would accomplish.

There was a time, not so long ago, when as a result of a report submitted by a committee composed mostly of Washington members of the medical profession, the United States Congress decreed that no coagulating or other chemicals could be used in the purification of the water supply of Washington, D.C. To-day, the water supplies of most of the government cantonments, construction camps, ship-building yards, etc., are treated with liquid chlorine in addition to the fact that the soldiers and sailors are all vaccinated against typhoid fever; and in most of the camps, the water is obtained from underground sources. Practically half of the state boards of health of this country are supplied with a portable emergency chlorine control apparatus, weighing about 40 lbs., mounted in a carrying case, which is shipped out to municipalities in the event of a sudden typhoid fever epidemic or scare. Such measures make for expedition, increase the confidence of cities in the aims and assistance of state health departments, and help lower the typhoid fever death rates of cities by giving prompt and efficient control of emergency conditions.

Liquid chlorine is used in the disinfection of all types of water supplies; *viz.*, water obtained from rivers, lakes, impounded supplies, shallow and deep wells, filter galleries, filtration systems, etc. Mountain streams, impounded supplies and well water are no longer considered



H, Hypo Treatment Started; F, Filtration Started; S, Hypo Stopped; P, Partial Disinfection Started; L, Liquid Chlorine Treatment Started

safe because they are obtained from the mountains, storage reservoirs and the ground. There are too many contaminating influences to be considered. The Chicago Bureau of Public Efficiency, in its report on the waterworks of Chicago, states that "a water supply contaminated on four or five days in a year, may result in serious epidemics."

Many cities have learned that liquid chlorine is a safe, cheap and reliable form of health insurance. The manager or superintendent of a water plant who uses liquid chlorine treatment does not have to lie awake at night fearful of the quality of his water supply.

The city of South Bend, Indiana, obtains its water from deep wells. The U.S. Public Health Service analyzed the water during the summer of 1917 and found B. coli present. Disinfection was ordered to be installed at once. This was done. It was found that the water coming from the wells was pure. The water being pumped from the storage reservoir was polluted. The chlorine was applied to the suction of the high-duty

pumps—beyond the last possible point of contamination. Then steps were taken to remedy the condition causing the contamination to the reservoir.

A small city in Michigan derived its supply from wells. The State Board of Health discovered a cross-connection with a pipe leading from the river.

Chlorination was ordered to be installed at such a point that whether the cross-connection was open or not, all of the water would be treated with liquid chlorine.

Many cities having supplies from underground sources have conditions similar to those at South Bend, and frequently have epidemics of intestinal disorders in their cities. Because a water comes from a deep well is no criterion of its purity as it is supplied to the consumer, if proper precautions are not taken to prevent its contamination. Frequent analyses of all water supplies should be made. Given the proper conditions, a spring, deep well or other originally pure water can and will become contaminated as quickly as a surface water.

Liquid Chlorine in Hospital Camps

Liquid chlorine is now being used in many of the government hospital camps in the United States and abroad, for the preparation of the Carrel-Dakin solution, which is used in the treatment of wounds.

A recent use for liquid chlorine has come to the notice of the writer. An Illinois city having a deep-well supply that has an iron content of two parts per million, aerates and filters the water to remove the iron. Recently considerable difficulty has been experienced due to the growth of crenothrix in the storage reservoir and distributing mains. Liquid chlorine is being used for killing this organism, because copper sulphate treatment has been unsuccessful.

Tanneries discharge liquid wastes carrying the anthrax organism. This germ is what is known as a spore former, and it is very difficult to kill it. The U.S. Bureau of Animal Industry has recently issued regulations governing the treatment of these wastes with liquid chlorine.

Packing houses discharge liquid wastes that have very disagreeable odors. Recent experiments on a large scale in a packing house indicate that it is possible so to treat these wastes with liquid chlorine that the odors will be rendered practically unnoticeable.

By means of liquid chlorine treatment, many other kinds of trade wastes can be successfully disinfected and the odor reduced to a point where no nuisance will be committed.

Swimming Pools Dangerous

Little thought has been given by the layman to the gross contamination that results from the use of the average swimming pool. The shower bath that is made a preliminary to the swim at most pools is usually a sham and does little good. A pool is certain to become highly polluted as a result of bathers using it. The modern method of keeping a swimming pool in a sanitary condition is to pump from the pool water at a rate sufficient to empty the pool in 18 to 24 hours. This water is forced through a pressure filter to clarify it and then it is sterilized with liquid chlorine and returned to the pool. In this manner a definite amount of polluted water is withdrawn from the pool and the same quantity of pure water returned to the pool continuously. No heating of the water is necessary in this purification process, as the water remains at the temperature of the pool.

Liquid chlorine is used as an adjunct to various methods of sewage treatment. The city of Cleveland, Ohio, is to install fine screens to clarify the city sewage and these screens will be followed by liquid chlorine disinfection. At many of the government camps, the sewage is sterilized by liquid chlorine, following treatment by septic tanks, filters and other systems. The amount of chlorine required is much greater than in the case of water purification, and varies from 40 to 90 lbs. per million gallons, depending upon the character of the sewage and the degree of purification desired.

As an example of what can be accomplished by chlorination of the water supply, the case of the city of Chicago offers excellent proof. Previous to 1900, all of the sewage of the city found its way into Lake Michigan, from which the water supply is taken. In 1900 the Chicago Drainage Canal was opened, which served as a method of disposing of the greater portion of the sewage. The Chicago River, formerly flowing into the lake, was reversed and was made to flow in the opposite direction, carrying with it the city sewage and a definite quantity of lake water for dilution purposes. As time went on, more and more sewage was diverted from the lake, and control was exercised over the dumping of dredgings in the lake, discharge of lake boat toilets in the vicinity of the water intake cribs, and other similar sanitary measures. The curve showing the typhoid fever death rate of Chicago is remarkable, because it shows what the above-mentioned measures accomplished, and it demonstrates what partial disinfection and what entire disinfection of the water supply will accomplish. Chlorine disinfection was in use at some of the pumping stations during the period 1911-1916, but during 1917 all of the water pumped by the nine stations was chlorinated. The drop in the typhoid fever death rate from 5.2 to 1.7 is wonderful. During 1917 only one sample of water out of 1,779 samples collected for analysis, or .06%, showed the presence of B.coli. in 1 c.c. B. coli was present in 5.4% of the 10 c.c. portions tested. In 1916 there were 135 deaths from typhoid fever, and in 1917 only 43.

Baltimore's Experience

Baltimore's water supply is derived from lakes. Previous to the use of chlorination, the average typhoid fever death rate for the period 1907-1910, inclusive, was 35.38. Hypochlorite treatment was begun in June, 1911. For the years 1912-1915, inclusive, the rate was 23.13 or a reduction of 34.6%. In September, 1915, a filtration plant was put into service and a further drop resulted in the typhoid fever death rate. Liquid chlorine was substituted in 1916 for hypochlorite of lime.

Jersey City was one of the first cities to adopt chlorination of the water supply, beginning the treatment in September, 1908. The average rate for the years 1900-1907, inclusive, was 18.7. For the period 1909-1917, inclusive, the average rate was only 7.3, or a reduction of 60%—truly a remarkable showing for water disinfection. The change from hypochlorite to liquid chlorine was made in February, 1913.

The curve shows typhoid fever death rates for Detroit from 1900 through 1917, but only the four-year period 1909-1912 was considered in comparing the average rates before and after chlorination, in order to have the time periods comparable.

Hypochlorite treatment was begun in March, 1913, and the change to liquid chlorine was made three years later, in March, 1916. The average rate before chlorination was 19.25, and after chlorination 15.05, per 100,000, —a reduction of 21.8%.

How Waukegan Saved Lives

Waukegan, Illinois, is one of the many cities drawing its water supply from the Great Lakes which were forced to install water disinfection because of the large amount of

typhoid fever. The treatment was begun in April, 1912. Data are available only for the period from 1911 to the present time. In 1911 there were fourteen deaths from typhoid fever, and in 1912 there were twenty. The next year there were only two deaths, then for two years there were no deaths, and then three and six respectively for the two following years. In other words, for the entire period of five years since water disinfection was begun, there have been only eleven deaths from typhoid fever. The water supply at Waukegan should be filtered, because it usually carries considerable organic matter and turbidity. In this city the disinfection process has had exceptionally careful and conscientious supervision.

The Milwaukee curve shows an appreciable reduction in the typhoid rate after chlorination was practiced regularly. Hypochlorite was used June 21st to December 12th, 1910, not at all during 1911, February 2nd to March 18th, 1912, and then continuously after April 12th, 1912, until May, 1915, when liquid chlorine was substituted for hypochlorite and has been used continuously since that time. The average for the five-year period while disinfection was not in use (1906, 1907, 1908, 1909 and 1911) was 21.8. For the period 1913-1917, inclusive, the rate dropped to an average of 8.9, or a reduction of 59%.

Statistics Prove Chlorine's Efficiency

The water supply of Omaha is obtained from the Missouri River, which name is almost synonymous with "mud," and is coagulated and settled in large basins. In 1910 hypochlorite treatment was installed. For the period 1906-1909, inclusive, the typhoid fever rate was 99 per 100,000. For the period 1911-1917, inclusive, the rate was 25.4, a reduction of 74.3%, which is truly a remarkable accomplishment. The change to liquid chlorine was made in 1915. The death rate has steadily and consistently dropped since 1910, and for both 1916 and 1917 was below 5 per 100,000.

There is no doubt but that the use of liquid chlorine will continue to grow. The only danger is from over zealous sanitarians recommending its application in cases where it is not called for or in cases where it should be used in conjunction with some other process. As with all purifying agents, it has its limitations. Within its sphere of usage, it has demonstrated its reliability and simplicity, and its efficiency is proven by the above-mentioned typhoid fever statistics.

CANADIAN RAILWAYS AND CANALS

According to the annual report of the Department of Railways and Canals for the year ended March 31st, 1917, the total expenditure of the Dominion government for railways and canals was $48,226,082.40, of which just about $6,000,000 was for canals. The revenue for the year was $24,001,181.75, only about $500,000 of which came from canals. The total expenditure on railways and canals and revenue from them, up to March 31st, 1917, is as follows:—

Expenditure on railways	$734,998,814.43
Expenditure on canals	164,140,734.44
Expenditure common to both	1,457,384.31
Revenue from railways	248,395,298.47
Revenue from canals	16,665,271.32

The railway expenditure for the year ended March 31st, 1917, included $14,737,326.70 charged to capital account. This consisted of expenditure on the Quebec bridge, the Intercolonial Railway, the National Transcontinental, the Prince Edward Island Railway, the Hudson's Bay Railway, and other items. The expenditure on the Intercolonial on revenue account was over $15,000,000, on the Prince Edward Island over $800,000 and on the National Transcontinental almost $8,000,000.

EFFECT OF WATER IN CONCRETE

DOES the strength of concrete for given materials, made up and tested in a similar manner, depend upon nothing except the relation between the amounts of water and cement in the mix? Duff A. Abrams, professor in charge of the structural materials laboratory of the Lewis Institute, Chicago, claims that it does, so long as a plastic mix is secured. In an article written for "Engineering News-Record," of New York City, Prof. Abrams indicates that the aggregate plays no part in the strength of the concrete except insofar as its properties affect the quantity of water required. Commenting upon Prof. Abrams' article, the "Engineering News-Record" says editorially:—

"Entirely Without Precedent," Says Editor

"The article by Prof. Abrams on the basic principle of concrete mixes is noteworthy for the consistency of its data and the simplicity of its indications. The studies which have been carried out in the structural materials laboratory of Lewis Institute are entirely without precedent, bringing out clearly the fact that former studies of this kind have failed to reveal the elemental principles of concrete proportioning. Past failures can be traced to the circumstance that but little systematic effort was made to analyze the factors which affect the strength and other properties of this material. . . . These investigations also lead to many important conclusions regarding the testing of cement. For instance, it is Professor Abrams' belief that the whole scheme of cement testing should be radically modified. The data in the article suggest that if strength tests of cement were made on neat specimens of such a consistency that the water content were the same as that used in ordinary concrete mixes, a strength would be obtained which would be an exact indication of the strength of the concrete itself—clearly intimating that the testing of cement in connection with sand or aggregates tends only to complicate the problem while not serving any useful purpose. This supposition has been remarkably borne out in the experiments which are being carried on. Professor Abrams has found that neat cement mixed with about twice the amount of water indicated by the test for normal consistency exhibits, in compression, about the same strength as is shown by a 1:2:4 concrete specimen in which the relative quantity of water is about the same. Since purely physical facts are found inevitably by systematic study, it is unfortunate that there are not a greater number of laboratories devoting their attention to the many problems, so far indeterminate, with which the engineer has to deal. The example of the Portland Cement Association in bearing so great a part of the cost of Professor Abrams' work is one that should be followed more frequently."

The article to which the above-quoted editorial refers, is reprinted here in full on account of the apparently revolutionary results obtained:—

Water is Essential Element of Mix

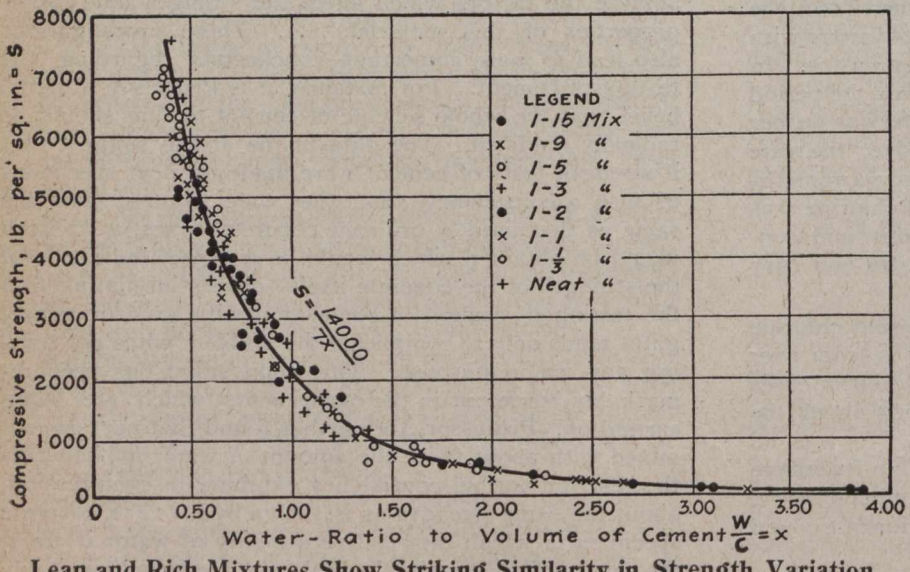
Concrete, it is commonly stated, is composed of a mixture of cement, sand and pebbles or crushed stone. This conception of concrete overlooks one essential element of the mixture—water. An exact statement of the ingredients of concrete would be: Cement, aggregate and water. The last-named material has not yet received proper consideration in tests of concrete or in specifications for concrete work.

Early users of concrete centered their entire attention on the quality of the cement, and practically disregarded

the characteristics of the other ingredients. During the past dozen years some attention has been given to the importance of the aggregate, but it is only recently that we have learned that the water also requires consideration.

Full Significance of Water Not Realized

A great deal has been said and written recently concerning the effect of water on the strength and other properties of concrete, but the full significance of this ingredient has not heretofore been pointed out. A discussion which appeared in the April, 1917, issue of the Concrete Highway Magazine gave a brief review of results of some of the experimental work carried out along this line at the Structural Materials Research Laboratory, Lewis Institute, Chicago. The relation between the water content and the compressive strength of the concrete for a wide range of consistencies was there pointed out and emphasis was placed on the injurious effect of too much water. Tests made in studies of the effect of size and grading of aggregates have shown that the only reason concrete of higher strength and durability can be produced from well-graded aggregate as compared with a poorly graded aggregate is that the former can be mixed with less water. If this is not done no advantage is gained from using a well-graded aggregate. The following discussion shows that a similar conclusion can now be stated with reference to a rich concrete mix as compared with a lean one.



Lean and Rich Mixtures Show Striking Similarity in Strength Variation for Differing Water Contents

While the injurious effects of too much water in concrete is apparent, tests made in this laboratory show that the truly fundamental rolê played by water in concrete mixtures has been entirely overlooked in previous discussions of the subject. The relation referred to above is brought out by a series of compression tests of about sixteen hundred 6 x 12-in. concrete cylinders made up as follows:—

Mix Cement-Aggregate.	Ranges of Sizes of Aggregates.	Consistency.
1:15		
1:9	o-14-mesh sieve	
1:5	o- 4-mesh sieve	Different consistencies for each mix and aggregate.
1:3	o-¾-in.	
1:2	o-1½-in.	
1:1	o-2-in.	
1:½		
Neat		

The mixes used covered a wide range, as did also the grading of aggregate and consistency. The aggregates consisted of two sizes of sand and mixtures of sand and pebbles graded to the sizes shown. The mix is expressed in terms of volumes of dry cement and aggregate, regardless of grading; *i.e.*, a 1:5 mix is made up of 1 cu. ft. cement (1 sack) and 5 cu. ft. of aggregate as used, whether a sand or a coarse concrete mixture.

Many Different Combinations Studied

This series gives valuable information on the effect of changing the quantity of cement, the size of the aggregate and the quantity of water. The effect of many different combinations of these variables can be studied. One set of relations gives the effect of amount of cement using aggregates of different size and grading; another set of relations gives the effect of different quantities of water, varying both mix and size of aggregate. In all respects the tests bear out the indications of earlier and later series, and reveal the true relation between the strength and the proportions of the constituent materials in concrete. The figure shows the relation between the compressive strength and the water content for the 28-day tests. The water content of the concrete has been expressed as a ratio of the volume of cement, considering that the cement weighs 94 lbs. per cubic foot. Distinguishing marks are used for each mix, but no distinction is made between aggregates of different size or different consistencies.

When the compressive strength is plotted against the water in this way, a smooth curve is obtained, due to the overlapping of the points for different mixes. Values from dry concretes have been omitted. If these were used we should obtain a series of curves dropping downward and to the left from the curve shown. It is seen at once that the size and grading of the aggregate and the quantity of cement are no longer of any importance except in so far as these factors influence the quantity of water required to produce a workable mix. This gives us an entirely new conception of the function of the constituent materials entering into a concrete mix and is the most basic principle which has been discovered in our studies of concrete.

The equation of the curve is of the form,

$$S = A/B^x \qquad (1)$$

where S is the compressive strength of concrete and x is the ratio of the volume of water to the volume of cement in the batch, A and B are constants whose values depend on the quality of the cement used, the age of the concrete, and curing conditions.

Law of the Strength of Concrete

This equation expresses the law of strength of concrete so far as the proportions of materials are concerned. It is seen that for given concrete materials the strength depends on one factor only—the ratio of water to cement. Equations which have been proposed for this purpose contain terms which take into account such factors as quantity of cement, proportions of fine and coarse aggregate, voids in aggregate; but they have uniformly omitted the only item which is of any importance, the water.

The relation given above holds so long as the concrete is not too dry for maximum strength and the aggregate

not too coarse for a given quantity of cement; in other words, so long as we have a workable mix.

For the conditions of these tests, equation (1) becomes,

$$S = 14{,}000/7^x \qquad (2)$$

Other tests made in this laboratory have shown that the character of the aggregate makes little difference if it is clean and not structurally deficient. The absorption of the aggregate must be taken into account if comparison is being made of different aggregates.

In certain instances a 1:9 mix is as strong as a 1:2 mix, depending only on the water content. The strength of the concrete responds to changes in water, regardless of the reason for these changes.

It should not be concluded that these tests indicate that lean mixes can be substituted for richer ones without limit. We are always limited by the necessity of using sufficient water to secure a workable mix. So in the case of the grading of aggregates. The workability of the mix will in all cases dictate the minimum quantity of water that can be used. The importance of the workability factor in concrete is therefore brought out in its true relation.

The reason a rich mix gives higher strength than a lean one is that a workable concrete can be produced by a quantity of water which gives a lower ratio of water to cement. If an excess of water is used we are simply wasting cement. Rich mixes and coarse, well-graded aggregates are necessary as ever, but we now know just how these factors affect the strength of the concrete.

Curve May Be Used Practically

Practical use may be made of the curve in estimating the relative strength of concretes in which the water content is different for any reason. For example, a concrete mixed with 7.5 gallons of water (1 cu. ft.) to one sack of cement (allowance being made for absorption of aggregate) gave a strength in this series of 2,100 lbs. per square inch ($x = 1.00$). For $x = 0.80$ (6 gal. of water per sack of cement), we have 3,000 lbs. per square inch; for $x = 0.75$ (5.6 gal.) 3,300 lbs. per square inch. Concrete in a 1:4 mix (same as usual, 1:2:3 mix with a coarse sand) should be mixed with 5½ to 6 gallons of water per sack of cement.

The importance of any method of mixing, handling, placing and finishing concrete which will enable the work to be done with a minimum of water is at once apparent. It now seems that practically all faulty concrete work can be traced to the use of too much water.

These studies lead to many important conclusions with reference to such topics as tests of cement, tests of concrete containing admixtures, etc. Tests of cement from this viewpoint have been under way several weeks.

R. S. Crain, a contractor of Ottawa, has purchased the brick and terra cotta works at Beamsville, which has been closed for the past three years.

At the annual meeting of the Ontario section of the American Society of Mechanical Engineers, held in Toronto, May 27th, Prof. R. W. Angus, of the University of Toronto, was elected chairman for the ensuing year. Chester B. Hamilton, Jr., of the Hamilton Gear and Machine Co., Toronto, was re-elected as secretary. The members of the executive for the coming year are James Milne, of the Department of Works, Toronto; J. H. Billings, of the University of Toronto; and G. V. Ahara, of the Canadian Fairbanks-Morse Co., Toronto.

WATER RESOURCES OF BRITISH COLUMBIA*

By William Young
Controller of Water Rights, British Columbia

SPEAKING of the water resources of British Columbia, there is no territory of the same size on the continent of America so favorably situated in this respect. A glance at the map immediately reveals the immense stretches of water north and south. The value of this resource is not fully appreciated. We hear much of our wealth in forest and mines, but little of water, yet there is no resource of greater value to a country. The welfare of all our cities and towns depends upon a wholesome supply of domestic water; town and city lighting and electric railway systems depend upon this resource, also our mining industries, our pulp mills and the bulk of the arable land in the southern part of the province. On this resource depends our great salmon fishery industry, and speaking of inland transportation by water, in the southern part of the province a thousand miles have been navigated by vessels of 100 feet and upwards in length, while in the north there are large stretches of navigable waters the extent of which we are not as yet fully informed on. So, while it is not the intention to refer to more than the purposes of irrigation and water power, even such is too large a subject to fully cover in the space allotted to me and in the circumstances I can only direct your attention to some of the main features.

Irrigation

The extent to which water is used for irrigation purposes is perhaps not generally appreciated. With the exception of the lower mainland and the small areas along the coast, practically every district south of the 52nd parallel is dependent upon irrigation. According to the statistics of the Agricultural Department, slightly over 300,000 acres of land are given as being under cultivation throughout the province. Of these, 100,000 are cultivated under irrigation conditions. Now, when it is realized that by means of irrigation three blades of grass can be made to grow where one grows under dry farming conditions, the production from these 100,000 acres of land is one-third greater than that from the other 200,000. This land, in acreages varying from a few to some thousands, is situated in the several valleys along the banks of the rivers, wherever there are creeks. Although I have given the acreages cultivated under irrigation, there still remains 400,000 acres for which water rights have been acquired and which in time will be developed. The fruit industry of British Columbia has been developed entirely by irrigation and where 25 years ago, even less, districts, particularly in the Okanagan, were unknown as fruit-producing, to-day they stand in the same relation to Western Canada as the Niagara Peninsula does to Manitoba, Ontario and Quebec, and Annapolis Valley to the Maritime Provinces; so a great industry has been built up almost entirely dependent upon irrigation. When I first came into close touch with irrigationists of these districts, the thing that amazed me was the tons of fruit going to waste and the absence of canneries. I do not propose to make any statement as to the reason, but at that time you could go into any general store in the interior and find its shelves laden with canned goods shipped in from a distance of 2,500 miles. The failure of the first two canneries in the Okanagan, the reorganization of one and the fight it had to overcome the throttling methods of competition, is another question.

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*Abstracted from address delivered before the British Columbia Manufacturers' Association.

Although some of you may be informed on this, I make mention of it to acquaint you with the fact that a great industry has not and may not yet be free from such influences.

Power Sites

Passing to the water power resources of the province. I have only noted a few of the power sites because as yet we have little, if any, knowledge of a great portion of the province in this respect. We do know, however, that in practically every district there is a water power of first magnitude located. Beginning with the East Kootenay, on Elk River, there is a power of upwards of 10,000 horse-awaiting development. Coming west in the vicinity of Nelson are the developments at Bonnington Falls by the West Kootenay Power Company and Nelson city. At this location the river may be developed at a number of places. As a direct result of the development of Bonnington Falls we have the cities of Trail and Grand Forks and their smelters. In the first-mentioned is to be found one of the largest on the continent and I am informed the only one turning out silver, gold, zinc, lead and copper and a number of by-products.

South, we have two small developments in the vicinity of Grand Forks, with great possibilities on the Pend d'Oreille River awaiting development. In the Railway Belt at Revelstoke the city has a small development and although there are many power possibilities here, there has, as yet, been no real investigation to determine to what extent they may be developed. In the Kamloops district there are a number of sites, Adams River, Barriere River and Myrtle Falls. Of these, the Barriere has been developed by the city of Kamloops and is now supplying power to that city and for irrigation purposes along the Thompson River, the latter use increasing from year to year. In the Lillooet district there is a great power at Bridge River which may be said to be strategic to that whole district. Coming to the coast north of Vancouver, there are many power possibilities, the important developments being Powell River, Ocean Falls and Swanson Bay. There are a great many other sites of varying magnitude, of which we have as yet little knowledge. It is most interesting in this district to note that the great lakes, which form the headwaters of the west branch of the Fraser River and the south branch of the Skeena, are at an elevation of approximately 2,700 feet and about 20 miles from tide water. We have little knowledge of the divide between these lakes and the tide water, but it is obvious that there are possibilities that are enormous. In the vicinity of Prince Rupert are to be found a large number of locations of varying size, from a few hundred horse-power up to 20,000 or thereabout. Travelling eastward from Prince Rupert along the line of the Grand Trunk Pacific, there are many locations of first magnitude, of which as yet we have few facts, and as to that portion of the province to the north of this railway, there are many sites which remain to be investigated and which in time may be made use of.

Developments Planned for Vancouver Island

On Vancouver Island a number of excellent sites are to be noted, the developed ones being Jordan River, Goldstream, Nanaimo, and the Puntledge, while the undeveloped ones of first magnitude are Stamp Falls, Campbell River and Nimpkish River. At Swanson Bay one of the pulp companies has plans under way for a paper industry similar to the Powell River, Ocean Falls and Swanson Bay, but not of the magnitude of the two former in that the power available is not quite so great. Of the possibilities on the island, too much cannot be said of Campbell River. It is strategic to the whole island and, according to various opinions, ranges all the way from 100 to 150,000 horse-power or more, inasmuch as there are wonderful storage possibilities behind it.

Hundreds of Small Sites

Leaving Vancouver out of consideration for the present, I have briefly outlined to you the general location of power sites throughout the province, making no mention of the hundreds of small ones of which we have little knowledge, but which may be developed in a similar way to some 50 or 60 in and throughout the Kootenays—sites that produce from 50 to 200 horse-power and which are used for lighting and in the operation of mines and concentrators. It will be obvious to many of you that powers of such magnitude are of inestimable value when the time comes that here and there throughout the province industries spring up which can be operated by power from such sites.

SHIPBUILDING AT HALIFAX

SHIPBUILDING on an extensive scale at Halifax, N.S., is foreshadowed in a formal announcement by Hon. C. C. Ballantyne, Minister of Marine and Fisheries. Private interests have bought the former site of the Acadia Sugar Refinery, adjoining the drydock, and three shipbuilding berths will be erected. These berths will be large enough to accommodate boats of approximately 10,000 tons, and it is expected that ships will be launched within fifteen months. The enterprise is known as Halifax Shipbuilders, Limited, the prime movers being James Carruthers, J. W. Norcross and R. M. Wolvin. They contemplate an outlay of $3,000,000 or $4,000,000 on structures and equipment.

Mr. Ballantyne announced recently that he was negotiating for the erection of a modern shipbuilding plant somewhere on the Atlantic coast. It was pointed out editorially in *The Canadian Engineer* for May 9th, that Halifax is the port in Canada which needs shipbuilding the most and which nature built most ideally for the purpose. There is no other way in which a steady, plentiful and economical supply of labor can be assured for ship-repairing; and ship-repairing is essential at Halifax. Workmen can be transferred at a moment's notice from ship-building to ship-repairing jobs.

Big Help to Naval Authorities

Mr. Ballantyne says that the only assistance that the government is giving to the enterprise is the placing of a limited number of contracts at fixed prices for the construction of modern steel freighters of about 10,000 tons capacity. The government had not even indicated to the promoters any particular site upon which the yard should be established.

It is expected that the industry will employ between 3,000 and 4,000 men. The city council of Halifax has granted tax exemption to the company.

The construction of this shipbuilding plant will be a matter of great satisfaction to the naval authorities of Canada and Great Britain, who have for some time past keenly realized the advantage to their work which would accrue from the location of a large shipbuilding plant at Halifax. This plant will also be very useful after the war in providing repair facilities for modern marine machinery. There has been to date a great lack of such repair facilities at Halifax, with consequent detriment to the progress of that port.

ROTARY SNOW PLOW

AUTOMOBILES and motor trucks, by their comparatively sudden increase in popularity, have made useless most of the old-time methods of snow-road making, particularly on suburban streets and country roads in localities of heavy precipitation.

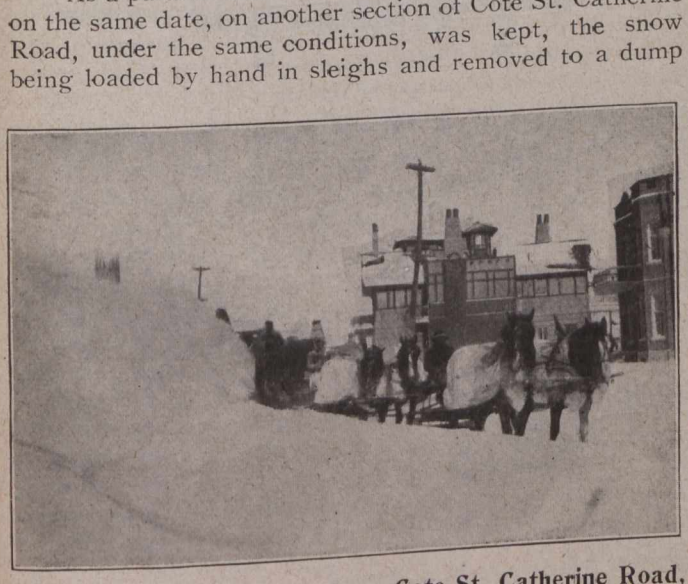
The road surface which would bear a sled, often breaks beneath the automobile. To maintain a road properly for this new travel by the old methods is often prohibited by the cost, and sometimes made impossible by labor scarcity. These conditions have led to the development by the Canadian Fairbanks-Morse Co., Limited, of the Stadig rotary snow plow. Besides making roads, after particularly heavy snow falls this machine has shown a greater capacity in clearing sidewalks than a thousand men with shovels.

Drawn against a snow bank by a team of two or four horses, this plow scoops up the snow and throws it aside. The horses only move the machine, the power for scooping up and discharging the snow being furnished by an engine which is a part of the apparatus.

Tests made by the city of Outremont, P.Q., on one of these plows, yielded valuable snow-removal data. The following from the report of February 6th, 1918, by City Engineer J. Duchastel to the mayor and aldermen of Outremont, gives a clear summary of results on Cote St. Catherine Road:—

"Figuring the cost of gasoline, time of operator, corporation teams and helpers, as well as time of grader and single snow plow used in connection with this work, we find that the cost per lineal yard of street cleared (one side only) is 7.2c. This work covers a period of 23 hours, and a bank of snow 6,775 feet long, 10 feet wide and 1 ft. 9 ins. high was cleared in that time.

"As a parallel to this work, the cost of removing snow on the same date, on another section of Cote St. Catherine Road, under the same conditions, was kept, the snow being loaded by hand in sleighs and removed to a dump



Rotary Snow Plow at Work on Cote St. Catherine Road, Outremont, P.Q.

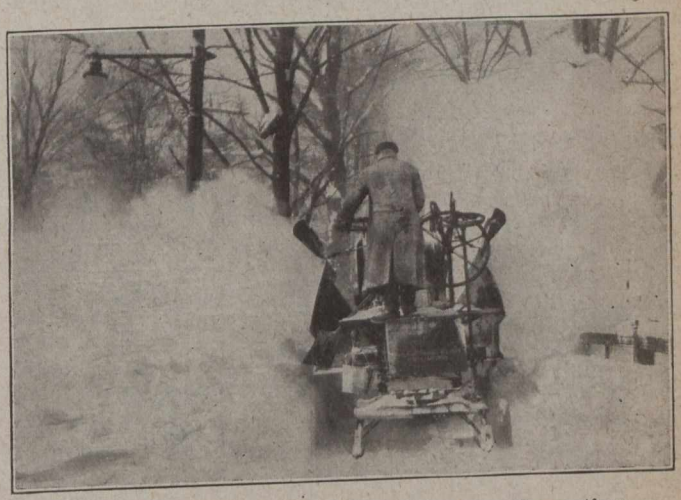
less than one-quarter of a mile away. The cost per lineal yard was 23.72c.; this work covers a period of 10 hours, and a bank of snow 950 ft. long, 10 ft. wide, and 1 ft. 9 ins. high was cleared in that time.

"As a check of these last figures, the cost of clearing Cote St. Catherine Road by this method was kept last year, and the figure per lineal yard of street (one side only) was, under practically the same circumstances, 27.4c."

In calculating these costs, 10% depreciation, 7% interest and a liberal amount for repairs were figured in addition to operating expenses. These data show that the road was cleared by the rotary snow plow at less than one-third the cost by hand.

Referring to the clearing of sidewalks, Mr. Duchastel's report says:—

"This machine was also used in opening up of sidewalks in sections of the city where drifts made them impassable. An accurate count was kept of this work, details of which I have on record in this office. From 11



Rear View of Rotary Snow Plow in Operation

to 12 miles of sidewalks per day have thus been cleared at the cost of $30.45 per day. It is difficult to arrive at the actual cost of this work by other methods, but I believe that I am not too optimistic in saying that a saving of 50% was made."

The common methods of snow-road making which were successful before the automobile became so universal, are the hand shovel, the "V" plow, the road grader and the snow roller. To these might be added the street railway company, when it happens to have a line along the road of immediate interest.

Where the snow is considerable, the first three methods require that it be taken away, because the banks would become so high after a few storms as to make continued clearings almost impossible.

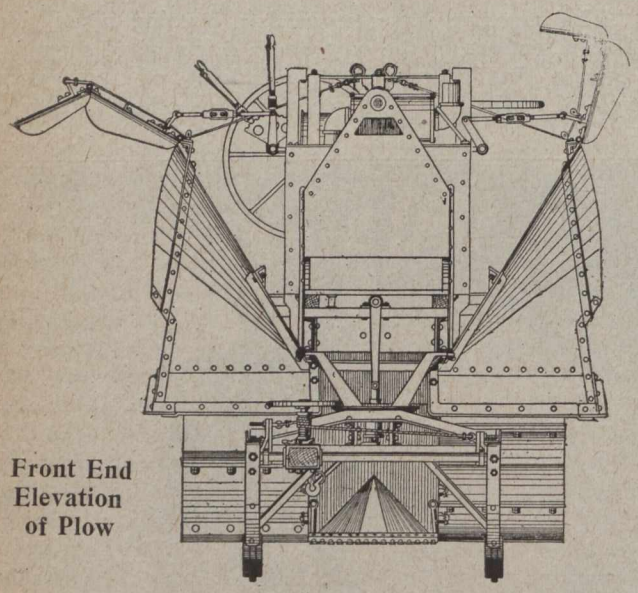
The snow roller is only satisfactory for sleigh roads and where the surface it leaves may be sprinkled, thus forming a heavy crust of ice; but the surface left by the roller, whether sprinkled or not, though satisfactory for sleighing, has not been sufficient to carry automobiles and heavy trucks. The rotary snow plow, says its inventor, does not necessitate the removal of the snow by human agency, because the plow throws the snow to a considerable distance, thereby distributing it over a large area or into the wind, which carries it away.

A four-bladed rotary cutter on each side of the machine, revolves on a horizontal shaft at 500 revolutions per minute, and scoops up the snow, discharging it from both sides of the machine. The snow may thus be thrown forty feet, being hurled clear for a distance of ten feet; or, if surroundings limit the distance to which it should be thrown, this may be controlled by moving the double dampers. The distance of projection may in this way be limited at will to any point from the extreme of forty feet to a discharge straight down.

The horses are not required to do very heavy work. The machine slides on runners; the front sled is high

enough to clear a 24-inch bank of snow without dragging. If desired, the machine may be set to an offset on the front and rear sleds, so that when cutting the bank away in widening the road, the horses travel on part of the road already cleared.

In one traverse the machine clears a space 5½ feet wide. The depth of cut and the slope of its surface may



Front End Elevation of Plow

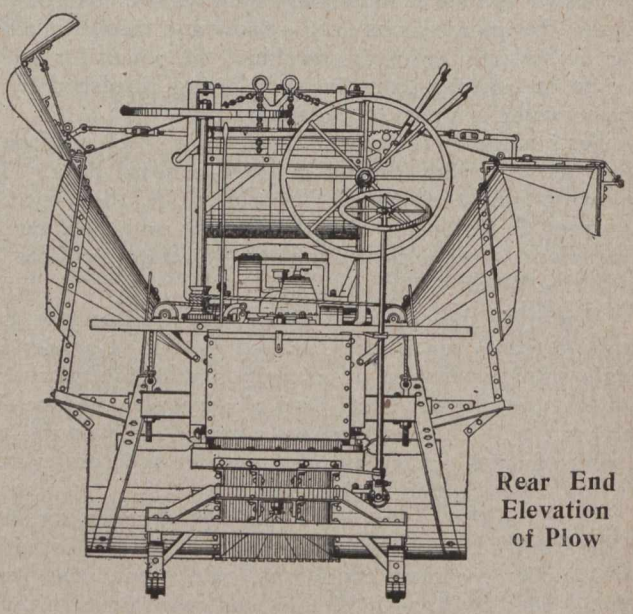
be regulated by moving the rotary cutters as the machine passes along. Thus the surface of the road can be made everywhere the same height. An uneven or tilted surface can be levelled; or a 22-inch comb, 1 inch to 4 inches high, can be left by centre plow adjustment. In two traverses (out and return) a road 11 feet wide can be cut, and this width can be increased by additional traverses, the snow being thrown beyond the part already cleared.

At the Good Roads Congress held this month in Hamilton, Ont., the following discussion arose concerning this new snow plow:—

Col. T. Hugh Boorman, of New York City: "I notice in the hall a picture of a rotary snow plow which has been used in Outremont. I came to Canada to see if there is any possible way, in these days of war, of economizing. I understand there is great shortage of labor, and any man who is saving an hour's time is doing his bit. I am sure we should be glad to hear if you could tell us whether there is any saving of labor by the use of the Stadig machine."

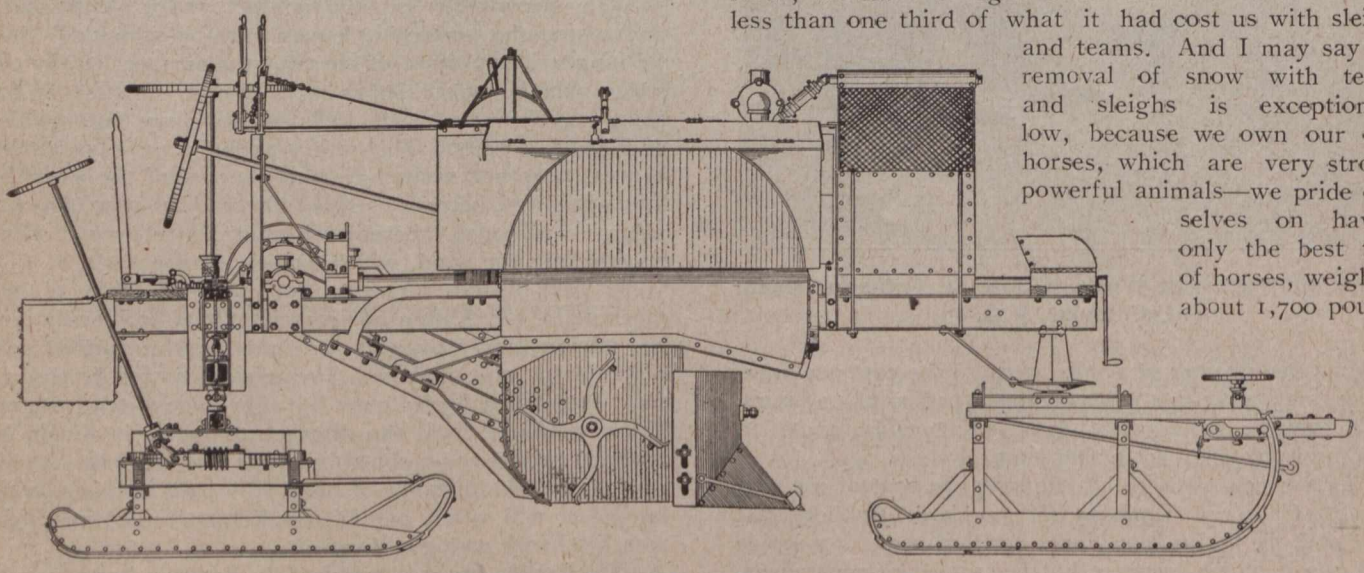
The president of the congress, Mr. Duchastel: "I will be very pleased to give you my experience with the machine. We have in the locality of which I am engineer, a machine built on the Stadig patent. While I admit that it is not a machine to be used in a city proper, it has done wonderful work in our suburban area. We have building regulations that are rather severe and our streets are rather wide. They vary between sixty-five and eighty feet, and we compel the citizens to build their houses anywhere from ten to thirty feet back from the street line. I bring this out simply to show you we have plenty of space on which to throw the snow.

"We have used this machine for one year. The machine picks up the snow with a rotary plow and pro-



Rear End Elevation of Plow

jects it to either side. Flanges direct the snow, and if the wind is high, a great quantity of this snow is blown away. I have had figures very closely calculated on the work performed by this machine, including the cost of operation, the cost of depreciation, and so forth. I have found that we have economized on our main thoroughfares; we have brought down the cost of removal to less than one third of what it had cost us with sleighs and teams. And I may say our removal of snow with teams and sleighs is exceptionally low, because we own our own horses, which are very strong, powerful animals—we pride ourselves on having only the best type of horses, weighing about 1,700 pounds



Sketch Showing General Assembly of Rotary Snow Plow

each—and our dumps are very close. Even then, with the low cost of dumping, we have cut down that cost to one-third.

"I strongly recommend that type of machine for open districts. On the rural roads, possibly, you could not get through drifts as large as those pointed out to us yesterday by Col. Sohier, with a machine of this kind, because you naturally can only get through the drift through which your horses will pull you through.

"We had four horses on this work, and in some exceptional conditions we might require six, but we have opened up as much as eleven or twelve miles of sidewalks, banked up on both sides, in one day. I think that is all I can say. As to the remarks of Mr. Drinkwater in connection with the snow roller, I agree entirely with him. It is very good to use a roller and a very practical way to maintain winter roads when you have to contend with sleighing alone, but it only hardens the surface or crust of the roadway, and when you have a slight thaw the roads get rutty in no time."

ABOLISH OPEN WELLS IN MUNICIPALITIES*

By W. C. Duncan, Columbus, Indiana

OURS is comparatively a new country—for within the memory of some yet living, where we meet to-day, the capital of our state, a city of 300,000 inhabitants, was once but a wilderness inhabited only by savage beasts and more savage men. The problem of the pioneer in life protection was a different one from ours to-day. Then he found it necessary, when he left his lonely cabin, to carry his rifle ever upon his shoulder, not knowing what moment he should meet the foe of civilized life, and it be necessary to grapple with him in a death struggle.

He had to depend upon himself for security of person and property. But as civilization advances and both people and property gather together, concentrating in cities, they find it convenient to put away the rifle, and all joining in a community effort, they employ a few officers and commit to them the protection of life and property while the others go about their labors in the day time, and lie down at night to rest in a measure of peace and security. The foe of life now is a more insidious one than the pioneer had to meet, but is just as relentless and as destructive to life. This foe comes with a congested population everywhere, in the form of disease germs.

These represent community diseases and must find a way into the human body through one of the avenues of air, food or water. The special subject assigned me on this program, "Why Private Wells in Municipalities Should be Abolished," I much prefer should read "Why Open Wells in Municipalities Should be Abolished." The word "private" is broad and sweeping and involves some rather innocent with guilty wells, for in many localities there are deep driven wells that do not offend so much as sources of water supply, while the open well is the dug well, which we hope to be able to show you is a natural draw for polluted surface water. Under my own personal observation, the open well in the city of Columbus in years gone by has been the source of serious prostration of families by typhoid fever. One instance in particular, where a whole family, one after another, through a long period, hovered between life and death, becoming a helpless charge on the community, costing the associated charities of our city more than $2,000. It was not until after the second family came down with the same disease from the same well, that this well was condemned and put out of commission. That the open, or excavated well is subjected to infection from surface drainage is now conceded. But does anyone know how far out from its mouth its suction will extend on the surface? Of course the answer to this will depend upon the character of the soil surrounding the well. We can get some idea by analagous reasoning. As an illustration, take the farmer's experience in draining his fields of surface water. He lays his tile, say, a 4-inch tile, two feet under ground, and he knows that thus laid it will drain out the surface water for one rod each way. He puts it down six inches deeper and it will drain two rods each way. And so on in an arithmetical progression—the deeper he lays this tile the farther out its drainage capacity will extend.

Apply these results to an open well 4 feet in diameter instead of 4 inches, and extended into the earth 20 feet instead of 2 feet, how far will it draw upon the surface water? One thing certain, it will draw a long way until filled up full of water, when the resisting pressure would be restored but the water circulation would still reach the infected sources. Now, as I said before, if this source of water supply is to be abolished, it should only be when an ample quantity of pure water is supplied in its place. The city of Columbus had this water problem for years, and thrashed it out through long and bitter experiences, and with many makeshifts, but I am happy to say that it settled down in a practical and effectual way when it built its present filtration plant, some six years ago. We have had it in use now long enough to see its advantages. We have had a distinct decrease in all water-borne diseases since it came into use. We lack something yet, along the line of a riddance of these open wells in our city. We have been trying for several years by a sanitary survey of the city to locate all of these with a view to putting them our of existence as soon as possible. Our city owns its water system and is furnishing pure water at the lowest rate of any city in our state. We are just now wrestling with the problem of how to increase the revenues of the water service to self-supporting principles. Our city, like many others, and like all should do, has gone to great expense in providing a pure water supply for its people.

That, as an investment for the public health and comfort, is worth all it costs the people. But the city, like any other prudent investor of capital, should see to it that all of the inhabitants of the city have a chance to get its benefits. For this only will measure up to the full benefits in health, convenience and comfort which this investment will bring to the people of the city. I will propose as a solution of the revenue question, not a raise in rates, but, instead, that every property owner, where a family shall reside, be required to put the city water privileges on the premises and in the residence, and all water rents be collectable from the property owner, and make their collection as certain as taxes are assured.

Having provided something better in pure water, we may abolish the open cesspool well and eliminate from the city typhoid fever and other diseases from polluted water. The water service, being properly handled, will have ample revenues for its support, at rates so reasonable that no one will have a just right to complain. Last, but not least, this will make it possible for the lawn in the home of the tenant as well as the landlord, to have its green sward throughout the summer and contribute to the beauty and refreshment of the whole city, and thus utilize all the benefits and blessings that may be available from the investment in pure water.

*Abstracted from address at the Eleventh Annual Meeting of the Indiana Sanitary and Water Supply Association.

CANADIAN SHIPBUILDING COSTS

By George W. Austen
Toronto, Ont.

AT present there are in Canada fourteen shipyards in which steel freight vessels are being built. Most of them are still working on ships for the British government, ordered through the Imperial Munitions Board. But in Montreal, the Canadian Vickers Company has in hand two steel freight vessels for the Canadian government. One is 8,100 tons and the other 4,350 tons. In Vancouver a steel freighter for the government is being constructed. It is about 5,000 tons. At Collingwood, another of 3,550 tons is on the ways. These are the first vessels in the government's new State fleet programme, and the Montreal pair will, it is expected, be completed by autumn.

As the contracts of the Imperial Munitions Board are filled, new contracts will be placed by the Dominion government for vessels. It is expected that a tonnage of about 250,000 can be built in the fourteen yards, but it will be the end of this year before the majority of the yards will be free for building for the Dominion. The intention of the minister of marine and fisheries, with the approval of his colleagues, is to continue the building programme over a period of several years, devoting $30,000,000, $40,000,000 or $50,000,000 annually to the project. At the end of the period, Canada will have a large fleet of ocean freight vessels, a steel shipbuilding industry firmly established, and a seafaring population of much national worth. Unquestionably the programme will have a large effect upon our economic future, especially as after the war the trade competition on the seas will be the most acute ever experienced.

The Future of the Industry

It is rather curious, however, that no one seems to have questioned the costs of the programme, and their effect upon the future of the Canadian ship industry. Since the government provides the money, and everyone welcomes the building of steel ships, the secondary economic features of the programme do not appeal to the public. Yet, in the final analysis, the costs will have an important part in determining our maritime future. When normal conditions are re-established in ocean traffic, and cheap building and ship-manning exert their customary influence, we shall experience some of the ill-effects of the high costs incidental to the present ship emergency. We shall not be alone, of course, but it seems to be true that the steel ships we are building cost more than similar ships built in the United States and Britain. If the government undertakes the operation of the ships, the comparatively high initial cost will not handicap operating rates the same as would be the case in private ownership. Either the ships can be operated with no profit, or the excess cost written off.

Ocean transportation is a peculiar business, and a very difficult one. In it the shipowners of a free trade nation have an immense advantage, because of the lower costs of building and operation, and the extensiveness of the carrying that is done through large imports. But after the war, no nation is likely to have real free trade. The fiscal requirements of Britain, for instance, will force it to maintain heavy duties on many commodities, and the exclusion of German trade also may compel the British government to reconstruct the fiscal system. But experience before the war, during long decades of vicissitudes in the ocean-carrying business, has proven that, given a fair field, the British shipping companies will be undisputed masters of world traffic. They will have the big advantage of being able to build ships much more cheaply than overseas nations. The United States is calculating that its quantity production of steel ships will enable it to build them after the war as cheaply as Britain. But that is yet undemonstrated.

The president of the American Shipbuilding Company recently gave interesting figures, to show that construction costs in the United States are still excessive. The average daily wage for a nine-hour day in British, ten-hour day in Japanese, and eight-hour day in American yards is:—

	Britain.	Japan.	United States.
Skilled	$2.16 to $2.79	75 to 90c.	$5.80
Semi-skilled .	1.94	70	4.40
Unskilled ...	1.81	60	3.20

Since the cost of labor is about 50 per cent. in a steel ship, the difference in favor of Britain and Japan is startling. At present, steel ship plates are worth about $200 a ton in Japan, owing to shortage, compared with about $65 in the United States, thus equalizing the lower cost of labor. But if conditions return to normal with reasonable quickness after the war, it is certain that British and other European building costs will be far below American, in spite of the advantage the latter may have in the output of plates. Before the war, wages in British yards were about $15 for skilled labor and as low as $5 a week for unskilled. There can be no return to such low levels, but will not the proportionate cheapness of construction still remain heavily in favor of Britain?

Now, such conditions as these have a special meaning for Canada. Our costs of steel shipbuilding are higher than those in the United States. The average of wages for skilled labor in Canadian yards is from $3.75 to $5.50 a day, and from $2.75 to $3.75 for unskilled. This is somewhat lower than the American rate, but the difference is made up by higher costs of fittings and other material. The average price paid by the United States Emergency Fleet Corporation for steel ships is about $160 a ton, and, while figures of Canadian government contracts have not been published, it may be taken that they are probably close to $200 a ton. The gross cost estimated by the minister of marine and fisheries for a tonnage programme bears such a relation. Now, the contract of the government with the Dominion Iron and Steel Corporation for steel plates is based on a price of $4.25 per hundred pounds with ingots at about $24 a ton. The tonnage price for plates is, therefore, about $85, compared with the United States' price of about $65. On 250,000 tons of steel ships, there would be about 80,000 tons of plates and sections, and $20 a ton difference—it would be less, perhaps, because of freight and other charges—would make an excess charge of $1,600,000.

British Tonnage Still Much Cheaper

Some big transactions have occurred in British tonnage at prices approximating $80 a ton. This price has some relation to the replacement value after the war. The pre-war value of steel tonnage was from $40 to $50, and we interests will succeed in keeping costs at least down to may be sure that the skill and ability of British shipping the $80-a-ton level. If our Canadian government freighters cost nearly $200 a ton, what an excessive capital cost must be loaded on to them, compared with British ships, even those built now! Before the war, the British yards could turn out vessels from 25 to 50 per cent. cheaper than Canadian shipbuilders. This estimate is furnished by a Canadian shipbuilder. According to present relative costs, our ships must bear even a heavier

handicap. There is, of course, no alternative but to go on and build the ships, and, if necessary, write off the excess cost. Canada will need the ships. It needs a steel plate industry. It needs a ship-construction industry. The excess cost is as nothing compared with the waste of our railway era.

Germany built up a merchant marine of 5,000,000 tons by an elaborate system of subsidies and bounties. That merchant marine served Germany's trade interests so efficiently that the money devoted to subsidies was returned to the nation many times over. The experience of Canada is likely to be the same. Even if some of the fourteen shipyards now building steel vessels die off when the government contracts are finished, the remaining ones will have been so strengthened as to be able to compete on a fairly good basis for outside business. But it is probable that the expansion of Canadian business and traffic after the war will give them plenty of Canadian orders.

WATER TOWERS AND STANDPIPES*

FOR the most satisfactory and economical operation of any waterworks plant, an elevated reservoir is a necessity. It gives a reserve supply for fire protection, a high and uniform pressure on the mains and a minimum cost of pumping. If a natural elevation is available, a flat-bottom standpipe of large diameter and small height placed directly on the foundations is the most economical structure. When no elevation is available within a reasonable distance, a steel tower and tank is the proper substitute. In deciding whether a water-tower or standpipe should be used, account should be taken of the advantage of central location as well as the cost of laying additional pipe to reach the desired location.

While a standpipe is well adapted to meet certain conditions, one of small diameter and large height is never satisfactory. The first metal structures built for the storage of water were standpipes only a few feet in diameter and of sufficient height to give, when filled, the pressure required. Such a design is uneconomical, as the amount of serviceable water stored in such a tank is only a small portion of the total capacity. The water below an elevation of eighty feet is of little value for fire protection, and serves only to support the water above that point. Several times more water can be stored at an effective height for the same cost by a water-tower than by a standpipe. The tall cylinder of small diameter also has the great disadvantage of extreme variation in pressure between the time when it is full and empty. The water-tower and standpipe are not rivals, but each has its own distinct field of usefulness.

A tank should be of sufficient capacity to store the water used during the hours when the pumps are shut down and also leave at all times sufficient water in the tank to supply one or more fire streams for a reasonable period of time. Fifty gallons per inhabitant, with a liberal allowance for an increase of population, should be the minimum capacity provided, and no tank for municipal service should hold less than 30,000 gallons.

The height to the bottom of the tank should be at least eighty feet above the ground level at all points where the fire protection is needed. It is, however, often possible to locate the tank on a natural elevation so that the water-tower itself will not need to be eighty feet high.

*Abstracted from an article in April issue of "The Water Tower," house organ of the Chicago Bridge & Iron Co.

LETTER TO THE EDITOR

Gas From Waste Wood

Sir,—Replying to your letter of April 18th, the process of gas making from wood which we have been working upon here, has for its purpose the utilization of waste wood rather than the use of cord wood, making the charcoal residues of questionable value, since they are too fine for any of the ordinary uses of charcoal if the waste used is hogged wood. It is therefore difficult to make a comparison of costs by this process with the analysis of Riche costs given by Mr. Bacque in his recent article in your paper.

As a general proposition we have been able to get eight cubic feet of 480 B.t.u. gas from a pound of moderately resinous wood such as Douglas fir, this material being weighed with about 15% moisture. From this you can make your own estimate of the cost of 1,000 feet of gas of this quality, so far as costs of material alone are concerned, with any priced wood that you may assume. The comparison with the Riche costs will be unfavorable unless something can be secured as a credit by the sale of charcoal.

Mr. Bacque figures that with wood at $4.00 a ton, the net cost of materials would be 12.77 cents. If this same wood were to be made into 480 B.t.u. gas by our process, the cost, with no credit for charcoal, would be 25 cents per 1,000 feet, provided it gave the same yields of gas that Douglas fir will give. The gas would be better than Riche gas, however, by 160 B.t.u. per cubic foot, and allowing for this difference, the cost would still be greater for materials, since 320 B.t.u. in 480 B.t.u. gas costing 25 cents, would be nearly 17 cents.

I may say, however, that gas having the higher value in heat units is worth more for town distribution, unit for unit, than the other, since it is more desirable in domestic appliances and is cheaper to distribute. I suspect that operating and other costs in the process which we have may be less than in a Riche plant, and the further fact that waste wood or peat may be used is also in its favor.

I am very much interested to note from Mr. Bacque's article how satisfactory 320 B.t.u. gas was found to be for domestic use at Three Rivers, P.Q.

We are not quite ready as yet to make public the details concerning our process.

O. F. STAFFORD,
Department of Chemistry,
University of Oregon.

Eugene, Oregon, May 14th, 1918.

Manitoba last year co-operated with the municipalities of Portage-la-Prairie, Sifton, Wallace and others in the starting of road improvement schemes totalling an estimated expenditure of $459,000. This work was not all completed last year, much of it being left until after the war, but the more essential parts of the work are now being undertaken, such as the renewal of old bridges and culverts.

The Alberta government has refused the application of Edmonton for permission to discontinue the experimental sewage disposal stations. It is understood that the provincial government will not depart from their ruling which made it obligatory upon the city that sewage could only be discharged into the river on condition that preparations be made to ascertain the best method of sewage disposal, and that within a period the discharge into the river must stop. On this account the city has been spending annually quite a sum in testing the most recommended systems of sewage disposal. The late sewer maintenance superintendent, E. Evans, who had charge of the disposal plants, has already been given notice of dismissal by the city commissioners.

DEHYDRATED CONTRACTS*

By Albert P. Greensfelder
President, American Society of Engineering-Contractors

MY appearance to-day before this convention to address you on this selected topic, is due to a recent conference with one of your members, E. E. Wall, water commissioner of St. Louis. We were part of a committee appointed by the St. Louis Association of Members of the American Society of Civil Engineers, to present the matter of a uniform engineering contract before the national board of directors of that body. The suggestion was made that your association would undoubtedly be interested in a similar document for general use of your members. On behalf of the American Society of Engineering-Contractors, therefore, it was felt incumbent upon me to present this subject for your earnest consideration, and to offer our co-operation.

Can You Write a Contract?

Contracts are not engineering products, but merely recipes for moral behavior. Waterworks were built by the ancients probably without such entangling alliances. The early Roman aqueducts were constructed without contractual relations, other than those of temperature. Even to-day, water free from impurities and injurious bacteria is possible without introduction of paper documents. Why, then, are there such impedimenta as contracts?

Contracts are often defined as bargains or agreements, enforceable by law. The law of nature is not implied, but the law of man. Contracts, therefore, have a human significance and it is that side which is the burden of my plea. You men who construct, operate and maintain the waterworks of this country are no small benefactors of mankind. Civilized anatomies demand water of quality, and civilizing industries require water in quantity.

Contracts *per se* affect neither of these, any more than do meters or pumping records. I do not believe there is a man in this room who, when qualifying his experience before his employer or examining board, was ever asked the question, Can you write a contract? If such test was a requirement of waterworks officials, I greatly fear for the constant supply at our faucets. Thus you will agree with me that contracts are dehydrated.

Dare Not Waste Efforts Now

If any one or several of us present, irrespective of our practical construction experience, were asked at this moment by your presiding officer to adjourn to an adjoining room and without books or references prepare and submit an equitable form of contract in five or even fifty hours, I suspect the results would be neither equitable, legal nor binding. Why, then; is the task so difficult or impossible of accomplishment? My answer is both yes and no. It is difficult because it is based on precedent and comparative experience, but it is not impossible, as has been amply proved in other fields of endeavor. By means of this simile you cannot help but grasp the purpose of my appeal.

The true purpose of any contract is to so clearly express one's intent that the meeting of minds of the two parties thereto is absolute. Much time, energy and money have been lost through neglect or inability to properly draft such instruments. In these days of conserved manpower and wealth, the necessity for proper contract forms is more essential than ever. We must not, dare not, waste efforts of any kind in these strenuous times. Our society, therefore, deems it both a prerogative and a duty to call upon its allies to function promptly and properly in this regard. Your members draft contracts which our members sign and execute. We are perfectly willing to abide by any form which your association may prepare, knowing full well that collectively your group has both the mind and purpose to present only that which would be equitable and fair.

Confusion and Delayed Undertakings

There can be no doubts even in the minds of your best professional contract-writing talent that this function can better be performed for the benefit of the profession as a whole, through preparation by your association as a body, than by the members individually as heretofore. There is no gainsaying the fact that occasional contracts have been and can again be, perhaps, better prepared by certain individuals equipped through brilliant minds, varied experience or unusual adaptability to perform such tasks. But even genius owes a duty to its profession which permits that genius to shine, and modern science recognizes its larger and broader duty to mankind and the public which supports it.

Much stigma has fallen upon technical and professional men and groups through improper or neglectful action in such public matters. Immature minds, youthful inexperience or slothful individuals have done great injury in the minds of their constituents towards splendid professions, such as yours, by their inadequacy or inaptitude in dealing with public funds which govern contracts.

Much confusion has resulted and many unnecessary legal tangles have delayed too many worthy undertakings fresh in the minds of my auditors to necessitate more than their mention now. Yet every time avoidable abstruse clauses or inequitable contracts cause complications and irritations in the public minds, just so many times do your members and your association gain public censure, deserved or not, depending on the point of view.

Suspicious of One-Sided Clauses

Is the public to blame for becoming impatient at excessive costs running unquestionably into hundreds of thousands of dollars annually, due to questionable terminology? Are contractors wholly to blame for being suspicious of the motives for insertion of special clauses and one-sided paragraphs? Are not bonding companies raising rates due to unnecessary penalty clauses and long-time guarantees? The banks charge more interest on retained percentages than city treasurers get, and payments for special materials delivered before incorporation in the work will make liens infrequent and prevent delays. Flexible methods of payments have been known to dispel disagreeable receiverships and arbitration clauses are merely human justice to eliminate interminable court proceedings. We are personally familiar with St. Louis and Louisville forms and acknowledge the unusual fairness and splendid abilities of both Mr. Wall and Mr. Wilson, and yet we hold no brief against possible betterments of even these documents. Again, we are in the midst of war, and war time equitable forms of bargain must be inserted in contracts if necessary work must proceed.

We might enlarge at length, but we are not here to-day to propose any favorite terms, to nurse pet hobbies for inclusion in your special contract form, or to propound

*Abstracted from address delivered before the annual convention of the American Water Works Association, May 15th, 1918.

any exclusive theorems for your elucidation. But we should like to have you feel that we are just as keenly alive to our obligations and responsibilities on our side as we know you are on yours. We have not been without reproach, and occasionally perhaps even worse, but we realize fully that through the influence of our members collected into a society, even as yours, our tendencies too are for improvement and sincere desire for co-operation on a continually rising plan.

Our society is composed of engineers on construction work and contractors in the engineering field. We uphold strict measures which make for quality of construction; we invite the proper placing of responsibility, and urge encouragement and recognition of construction service. We admit that we are human beings with human ambitions, but believe reliability is more worthy than cupidity. We remain in our profession because we enjoy its rewards, labors and sorrows better than in other fields of endeavor, and because we hope it is a genuine service to mankind. Help us along progressive lines and show us the light.

In conclusion, we seek no credit for this appeal, but we hope you will realize this civic opportunity and start this valuable work at once. If your board of directors upon request of the membership here assembled will appoint a standing committee on contract forms, to draft serviceable documents for your final action at your next convention, and such committee feels our society can assist it in any way, we beg to assure you we shall be glad to render service, endorse your results, and urge its use through our members and the public.

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† Following the address, the president of the American Water Works Association, Major Theo. A. Leisen, submitted Mr. Greensfelder's proposals to the meeting. They were warmly endorsed by those present.

FINDING LEAKS SAVES COAL

IN the issue for May 7th, 1918, the Buffalo, N.Y., News says: "Water Commissioner George C. Andrews has reported to Commissioner Kreinheder, of the department of public works, that during April water pumpage was reduced 361,000,000 gallons, with a saving of 415 tons of coal, which means a saving of $1,850.

"The Pitometer experts have been at work searching for underground leaks which do not show on the surface of the streets and have found in Wyoming Avenue leaks which discharge 265,000 gallons of water every 24 hours into a sewer. Two broken curb cocks and a faulty hydrant which had been covered over in repaving, caused those leaks. They have been repaired."

Bacteriology seems to be a field, in which woman is destined for special instruction, says the "Woman Citizen," of New York City. A young lady of 21, Miss Margaret McCluer, has assumed the post of bacteriologist of Richmond, Virginia, releasing the former city bacteriologist for direct war service. There is need for about 100 women bacteriologists to take the place of men in the cantonment laboratories, the Surgeon General's Office of the United States Army announces. The service of the men is demanded for the hospital units which are going abroad and their places at the home cantonments are to be filled by women. Applications are arriving from all the camps, some asking for as many as nine women.

HYDRAULICALLY OPERATED VALVES*

HIGH-PRESSURE steam lines equipped with hydraulically operated valves, carry insurance against loss by accident that often makes the cost of the "premium"—the price of the valve—negligible. Here is a case in point, one out of many that might be mentioned:

In a large power plant "somewhere in the east," one of the big 35,000-kw. turbines was disabled, due to an accident to the blades. The accident caused a very uneven motion of the machine and a consequent hammer that broke off a number of the foundation bolts. The turbine was set on a high concrete foundation which also supported another turbine. Due to the uneven motion of the engine, the whole foundation structure was set in vibration and imminently subjected to most costly damage; but there was a hydraulically operated valve on the main steam header, and it was operated in time to avoid further damage.

There is not the slightest doubt that in this instance the saving was incomparably greater than the original cost of the valve and its installation.

These hydraulically operated valves as safety devices in power plants have been proven to be desirable, economical and reliable. As a general rule they are operated from the boiler feed headers, which in a power plant are very rarely released from pressure; consequently the power necessary for the operation of the valve, when it is used in emergency cases, always is at hand. This gives the hydraulically operated valve thus installed a distinct advantage over valves actuated by other power, especially electrical power generated by the prime mover that the valve is intended to protect. For, should an accident occur to the prime mover—as in the case cited—the power to operate the valve might be cut off before the operation was complete.

Careful engineering practice would indicate that without exception any valve intended to be operated from a distance, in a case of emergency, should have its power supplied from a source wholly independent of the power to be affected by the closing of the valve. The accepted manner of installing hydraulically operated valves in the steam lines of power plants makes these valves uncommonly desirable and reliable.

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*From the "Valve World."

The Civic Light and Power Department, Edmonton, Alta., received three large contracts recently, to supply power to the University of Alberta, to the P. Burns Packing Company, and to the Pace Cannery of North Edmonton.

Theodore Morgan, of the firm of Henry Morgan & Company, Limited, department store, Montreal, stated last week in a newspaper interview that he feels certain that the present bad condition of Montreal's streets is causing $2,000,000 loss annually to the public through increased delivery costs, and extraordinary wear and tear on vehicles.

At a recent meeting of the Niagara Falls Board of Trade, a paper on carborundum was read by Francis R. Bowman. He described the discovery of the substance and its importance as a manufacture. The first plant of the Carborundum Company was located at Monongahela, Pa. During 1893, its first year of operation, the total output was 15,000 pounds. In 1895 it was decided to remove to Niagara Falls, on account of the possibilities of unlimited electric power to be secured there. A contract was accordingly made with the Niagara Falls Power Company for 1,000 horse-power. He pointed out how the confidence of the promoters has been justified, as the present plant covers 10 acres of floor space, is equipped to handle 25,000 horse-power, and upwards of 1,500,000 pounds of carborundum are made each month.

CONVENTION AT ATLANTIC CITY

PROVISIONAL programmes have been issued for the annual meetings of the American Society for Testing Materials and the American Concrete Institute. The latter organization will meet June 27th to 29th, while the former will meet June 25th to 28th, the headquarters for both meetings being the Hotel Traymore, Atlantic City, N.J.

On Thursday evening, June 27th, there will be a joint session of the two organizations. The programme for this session includes reports of committees on cement and reinforced concrete and treatment of concrete surfaces, and papers by J. C. Pearson on "Tests of Stucco"; W. A. Hull, "Tests of Concrete Columns"; D. A. Abrams, "Effect of Age on the Strength of Concrete"; L. N. Edwards, "Proportioning the Materials of Mortars and Concretes by Surface Areas of Aggregates."

The programme for the other sessions of the American Society for Testing Materials includes a large number of committee reports and papers on wrought iron, cast iron, steel, testing, industrial research, preservative coatings, non-ferrous metals, lubricants, cement, ceramics and road materials.

The programme for the other sessions of the American Concrete Institute include some committee reports and a number of papers on concrete properties and products, concrete design and tests, concrete roads and pavements, concrete structures and buildings and reinforced concrete barges and ships. Among the papers on this programme are the following:—

"Apparatus for Testing Under Uniform Load," by H. H. Scofield; "Plasticity and Temperature Deformations in Concrete," S. C. Hollister; "Concrete in Art Work," R. F. Havlik; "Problems in Concrete Surfaces," J. J. Earley; "Reinforced Concrete for Railway Purposes," Charles Gilman; "Moment Coefficients in Flat-Slab Design," W. K. Hatt; "Tests of Western Newspaper Building," A. N. Talbot and H. F. Gonnerman; "Theory and Test of Flat Slab with Ring Reinforcement," Edward Smulski; "Design of Concrete Chimneys," J. G. Mingle; "Concrete Roadways for the Industrial Plant," G. S. Eaton; "Effect of Time of Mixing on the Strength and Wearing Qualities of Concrete," D. A. Abrams; "Distortions and Vertical Changes of Concrete Pavement Slabs Due to Subgrade Movements," J. W. Lowell; "Surface Requirements for Concrete Roads," A. H. Hunter; "Progress in Concrete Pavement Design and Construction at Winnetka, Illinois," F. A. Windes; "Concrete Road Construction in Vermilion County, Illinois," P. C. McArdle; "Reinforced-Concrete Columns Under Eccentric Load," L. J. Mensch; "Core Construction," A. H. Bromley, Jr.; "Relation of Costs to Design of Reinforced-Concrete Buildings," C. W. Mayers; "Construction of C. & N. W. Railway Grain Elevator," C. F. Huffman; "Construction of Reinforced-Concrete Building for American Can Co.," N. W. Loney; "Flat-Slab Railway Bridges," A. B. Cohen; "Principles of Design of Concrete Ships," R. J. Wig and S. C. Hollister; "Concrete Ships," J. E. Freeman; "Concrete Ships," Archibald G. Monks; "Concrete Barges," O. F. Lackey.

Ten miles of grading were completed last year on the Portage Highway in Manitoba, and the grading of another sixteen miles is under contract for this season. This highway runs east and west through the province. During the past three years, thirty-five miles of it have been completed with permanent culverts and bridges and with gravel surface.

TORONTO WATER FILTERED, CHLORINATED

WORKS Commissioner R. C. Harris, of Toronto, has reported to the Board of Control of that city that the verMehr mechanical filter plant at Toronto Island is now complete with the exception of some minor adjustments of pipe lines, clearing and grading of site, and supply of an overhead crane for unloading coal and chemicals from barges and depositing them in the storage bins. The plant will not be taken over from the contractors finally until these details have been completed. All the units in the plant are now working, however, and all water that is pumped to the city is being filtered either in this plant or in the old slow sand plant. All the water is being chlorinated after filtration, a battery of Wallace & Tiernan liquid chlorinators having been installed some time ago. Col. George G. Nasmith has been asked by the Board of Control to submit a report on the success of the chlorination.

WIDE STREETS OR SUBWAYS?

CITY engineers to-day "are planning not only to solve their immediate transportation problems, but they are endeavoring to anticipate the future," says the Concrete Highway Magazine. "Many experts have agreed that the real solution for traffic congestion which will be effective fifty years hence, as well as relieve immediate congestion, is the adoption of the policy of wider streets and lower buildings.

"Adoption of subway and elevated trains to increase transportation facilities has proven of only temporary relief. The result has been to increase the possibilities for crowding more people into the same business district with consequent demand for higher buildings, more congestion and again increased transportation facilities—an unending chain of problems without a permanent solution.

"Transportation problems are in great measure solved when wider streets prevail. Traffic congestion is less and greater speed can be made between business and residential sections. Cars can be run oftener with increased traffic capacity and with greater safety and comfort. Fewer accidents result, which, aside from a humanitarian standpoint, eliminates a great proportion of the damage suit tax now part of the overhead expense of every transportation company.

"Surface lines on main radial streets with interweaving crosstown lines cover cities in a way which would be impossible for a subway system. The civic policy of wide street construction, now being adopted by many larger cities, offers permanent relief."

The new road over the Coal Harbor causeway, affording direct access to Stanley Park, B.C., is now open for automobile and light vehicular traffic. One section of the causeway next the wall has been graded and levelled, and now offers a fine roadway 16 feet wide. The handsome cut stone balustrade along the sea wall side of the park is finished and the stone columns for the ornamental lighting have been erected.

Under the direction of the highway department of the Province of Manitoba, an 86½-ft. span, reinforced concrete bridge was built last year over the Valley River in the municipality of Grandview. The design is a bowstring truss or open sprandrel arch with elastic abutments, the unique feature being that the floor is suspended from the arch ribs instead of being superimposed as usual in this type of bridge. The thrust from the arch ribs is taken by a horizontal tie at floor level and a system of roller bearings provides for horizontal displacement due to temperature expansion.

NEW 110-MILLION-GALLON PUMP AT THE CHAIN OF ROCKS, ST. LOUIS*

By L. A. Day

IN order to meet an increased demand for pumping capacity at the low-service pumping station of the city of St. Louis, a contract was awarded for a new De Laval turbine-driven centrifugal pump having a maximum capacity of 110,000,000 gallons per twenty-four hours. This will bring the total capacity of this station up to 290,000,000 gallons per twenty-four hours, which will be adequate for some time to come. The new pump will be located in the centre pit, there being three pits in all. There are at present two 30,000,000-gallon turbine-driven pumps in this pit. Room was made for the 60-inch suction valve on this pump by channelling off 3 feet of the ledge on the east side of the pit for its entire length north and south. This also provides enough room in the pit for the location of the necessary auxiliaries used in connection with the new pump. The ledge was cut from solid limestone. It was also necessary to tunnel a 60-inch suction line through the limestone for a distance of 40 feet to the suction well which is common to all engines in this station. In addition to the 60-inch suction valve which is located within the pit, stop logs are provided in the wet well for making repairs on the suction valve if needed. The operating floor of the pump pit is 12 feet above the bottom. An automatic push-button electric elevator is used to reach the turbine operating floor from the ground level of the pumping station, which is 45 feet above. The pump will be required to operate under varying heads as the river rises or falls. The average total discharge head will be 60 feet with a minimum of 45 feet and a maximum of 65 feet.

Against Head of 45 to 65 Feet

The discharge pipe will be 60-inch diameter and will drop below the floor and then rise vertically, paralleling the west pit wall. The pipe will be enlarged to 72 inches from a flanged Y, which is 60 inches by 72 inches by 42 inches, due to the north 30,000,000 centrifugal pump discharging its water through the same pipe. The new unit will be provided with a 60-inch hydraulically operated discharge valve close to the Y and the old unit with a 42-inch hydraulically operated valve close up to the 45 degree leg of the Y. The 72-inch line will be extended to the delivery well, which is a common discharge well for all pumps in this station. A 72-inch cast iron Venturi meter tube with a 36-inch throat diameter, the largest cast iron Venturi tube ever built, will be installed just outside of the pumping station.

The pump will deliver from 80,000,000 to 110,000,000 gallons in twenty-four hours against any head varying from 45 to 65 feet. This range of flexibility could not be met entirely with governor adjustment, but will be obtained by opening or closing hand-operated valves on the turbine; the speed of the unit thus obtaining will be further controlled by an automatic governor. This governor will be of the oil relay type, designed to permit of adjustment while the unit is in operation to any point within the required range of speed, and after being adjusted will maintain the required speed within 2 per cent. variation above or below.

*One of a series of four papers on St. Louis Water Works presented before the convention of the American Water Works Association held recently in that city.

The maximum brake horse-power of the turbine will be 1,550 and the maximum water horse-power required, including all pipe friction, will be 1,250; the speed of the turbine under these conditions will be 3,717 r.p.m. When the pump is delivering 80,000,000 gallons of water in twenty-four hours under a total head of 45 feet the turbine will run at 2,946 r.p.m. The pump speed will be lowered by means of reduction gears to 352 r.p.m. when delivering 110,000,000 gallons under 65 feet head, and to 279 r.p.m. when delivering 80,000,000 gallons under a 45-foot head. The guaranteed pump efficiency will be slightly above 80 per cent. under all of the specified head and capacity conditions. The suction and discharge openings to the pump will be 48 inches and the 60-inch suction and discharge piping will be gradually reduced near the pumps to this diameter.

Multi-Stage Impulse Type Turbine

The turbine is of the multistage impulse type and will operate with 125 pounds gauge pressure and 75° superheat. Provision will be made for bleeding 1,500 pounds of steam from one of the low-pressure stages for heating feed water. Bleeding this amount of steam will increase the B.t.u. duty of the unit approximately 3 per cent. The bleeder outlet will be provided with an automatic valve set to carry a pressure of 5 pounds gauge on the exhaust line at all times. The dry vacuum pump is of the horizontal crack-and-flywheel type designed to operate at a speed not to exceed 115 r.p.m. The condensate pump will be turbine-driven, connected to a centrifugal pump by means of reduction gears. The circulating pump will be direct connected to the main unit shaft, and will take its water from the 60-inch suction; after passing through the condenser the water will be discharged back into the main suction pipe. The condenser will be of the water-tube type placed directly under the turbine. Water for circulating purposes only will pass through the condenser, as an excessive amount of friction would have been obtained by passing all of the water pumped by the unit through the condenser, this being the usual waterworks practice. In order to drive as much heat as possible out of the exhaust steam going to the condenser a primary heater will be placed in the condenser and all the condensate from the condenser will be pumped through this heater before going to the hot well or open feed-water heater. The total condenser surface will be 2,825 square feet of seamless drawn brass tubes No. 18 B.W.G., 1 inch in diameter and 12 feet long.

Bidder's Guarantees

The unit was bought on the bidder's guarantees of duty per million B.t.u. consumed by the unit, including auxiliaries and bled steam, with the provision that the total amount of exhaust steam from the auxiliaries, plus the steam bled from the unit, should not exceed 2,200 pounds per hour.

The successful bidder's guarantees were as follow:—

100,000,000-GALLON			
Head in feet	45	60	65
50 circulating water	113.5	120	122
80 circulating water	106.5	113	115
80,000,000-GALLON			
Head in feet	45	60	65
50 circulating water	107	113.75	115
80 circulating water	101.5	108.50	109.5
110,000,000-GALLON			
Head in feet	45	60	65
50 circulating water	114	120.75	121.5
80 circulating water	107	113.50	114.0

The average duty for all of these conditions is 114,562,000 feet-pounds per million B.t.u.'s which is equivalent to a duty of 134,000,000 feet-pounds per 1,000 pounds of steam.

Attention is called to the fact that different duties are obtained with different temperatures of circulating water. This is due to the fact that if the turbine is designed properly, better economies will be obtained with low circulating-water temperatures, owing to an increased vacuum. The average circulating water temperatures for this station throughout the year are 50° for the winter and 80° for the summer. In order to compare bids on this unit the following information was embodied in the specifications:

"One million foot-pounds of duty will be valued at $2,000. That is, if bidder A guarantees 5,000,000 foot-pounds higher duty than bidder B, $10,000 will be added to B's bid for comparison with A's bid."

Bidders were instructed to submit curves showing duties guaranteed when pumping 80,000,000, 100,000,000 and 110,000,000 gallons with circulating water temperatures of 50° and 80° and heads of 45, 60 and 65 feet.

During four-fifths of the time each year the pump operates, it is estimated that it will be called on to deliver from 80,000,000 to 110,000,000 gallons under heads varying between 60 and 65 feet. During the remaining one-fifth of the year, it is assumed this pump will deliver from 80,000,000 to 110,000,000 gallons under a 45-foot head. It was further assumed that the unit will deliver 100,000,000 gallons for one-half of each year under all head conditions and the remaining half it will deliver either 80,000,000 or 110,000,000 gallons in equal parts.

The process may be represented diagrammatically as follows:

100,000,000 GALLONS DAILY

$$\frac{\text{Duty at } 50^\circ + \text{Duty at } 80^\circ}{2} \text{ for 45-ft. head} \times 1 = \ldots\ldots$$

Ditto for 60-ft. head × 2 = ...

Ditto for 65-ft. head × 2 = ...

5) Sum

Duty A

80,000,000 GALLONS DAILY

$$\frac{\text{Duty at } 50^\circ + \text{Duty at } 80^\circ}{2} \text{ for 45-ft. head} \times 1 = \ldots\ldots$$

Ditto for 60-ft. head × 2 = ...

Ditto for 65-ft. head × 2 = ...

5) Sum

Duty B

110,000,000 GALLONS DAILY

$$\frac{\text{Duty at } 50^\circ + \text{Duty at } 80^\circ}{2} \text{ for 45-ft. head} \times 1 = \ldots\ldots$$

Ditto for 60-ft. head × 2 = ...

Ditto for 65-ft. head × 2 = ...

5) Sum

Duty C

$$\text{Resultant Duty} = \frac{2 \times \text{Duty A} + \text{Duty B} + \text{Duty C}}{4}$$

All of the above conditions must be verified by complete shop tests before the unit is shipped. These shop tests must be on the turbine, gears and pump assembled complete. The shop tests must show duties at least those guaranteed by the contractor and checked by the city's representatives.

After the unit is installed it will be subjected to an endurance test of ten days of twenty-four hours each.

The physical data of the unit and auxiliaries is as follows:

Turbine

Make	De Laval
Brake horse-power of turbine	Normal 1,300, max. 1,550
Number of stages	13
Number and diameter of rotors	4—27½-in.; 9—24-in.
Revolutions per minute under maximum conditions	3,720
Method of speed control	Jahn's gov'r through oil relay
Percentage of speed obtainable above and below normal by governor regulations	6 above and 15 below
Percentage of speed obtainable above and below normal by hand-regulated nozzle	Approx. 6 above and 20 below
Net weight of turbine without bedplate, pounds	24,000
Diameter and length of bearings, inches	4½ x 14
Diameter of shaft in rotor, inches	10
Diameter of steam admission, inches	6
Diameter of steam exhaust, inches	36

Reduction Gear

Net weight of reduction gear complete without bedplate, pounds	32,000
Diameter of driven gear, inches	63.4
Diameter of pinion, inches	6
Width of face of gear in pinion, inches	29¼
Tooth pressure per inch, face of gear and pinion, when pump is delivering 110,000,000 gallons per day at 65-foot head, pounds	300
Gear ratio	10.56 to 1
Angle of gear tooth, degrees	45
Mechanical efficiency of gear, per cent.	98
Horse-power consumed by gear under maximum conditions	31

Pump

Net weight of pump without bedplate, pounds	40,000
Net weight of bedplate for complete unit, pounds	15,000
Diameter of impellers, inches	50
Diameter of shaft at impeller, inches	8
Diameter and length of bearings, inches	One 6½ x 18 One 5¼ x 18
Length of shaft between bearings, feet	8⅓
Revolutions per minute, maximum	352
Diameter of water suction, inches	48
Diameter of water discharge, inches	48
Efficiency of pump, per cent. (for normal conditions)	81

Condenser

Condensing surface, square feet	2,825
Diameter of tubes, inches	1
Gauge of tubes	No. 18 B.W.G.
Length of tubes, feet	12
Number of steam passes	1
Number of water passes	2
Size of exhaust-steam inlet, inches	36
Net weight of condenser, pounds	20,800
Diameter of condenser shell, feet	5
Length of shell, feet	14¾

Air Pump

Revolutions per minute	115
Size of inlet, inches	5
Size of outlet, inches	3
Method of driving air pump	By steam cylinders
Weight of air pump complete, pounds	6,400

Condensate Pump

Size of pump, inches	2½
Revolutions per minute	1,800
Size of inlet, inches	2½
Size of outlet, inches	2½

OTTAWA WORKS DEPARTMENT REPORT

DURING 1917, 1.89 miles of permanent pavements were laid in Ottawa, Ont., according to the annual report of Andrew F. Macallum, works commissioner of that city. This report, which has just been published by the city council, states that 26,248 square yards of asphalt were laid, 3,062 sq. yds. of sandstone block, and 3,130 sq. yds. of creosoted wood block. Following are excerpts from the report:—

The following schedule shows the approximate total area of the various classes of pavements laid in Ottawa from 1895 to 1917, inclusive:—

Class of Pavement	Total Miles including Repaving	Existing Mileage 1917	Total Area laid including Repaving curb to curb	Existing Surface Area, 1917, curb to curb
Asphalt	31.36	31.36	597,392	597,392
Asphalt and stone block	13.68	11.95	357,598	310,663
Asphalt and wood block	1.37	1.37	39,183	39,183
Bitulithic	0.54	0.54	4,600	4,600
Bitulithic and stone block	0.08	0.08	1,700	1,700
Rocmac	0.34	0.34	5,377	5,377
Stone block	0.53	0.47	11,960	10,346
Tarvia	2.91	2.91	47,515	47,515
Tar macadam ...	4.87	4.87	84,835	84,835
Tar macadam and stone block	0.08	0.08	1,868	1,868
Wood block	1.32	1.32	29,256	29,256
	57.08	55.29	1,181,284	1,132,735

Asphalt and stone block area includes 133,932 square yards stone block.

Asphalt and wood block area includes 15,078 square yards wood block.

Asphalt area and mileage includes asphalt macadam pavements.

Sewers

The Ottawa South trunk sewer was constructed to Main Street, leaving only a half mile to be completed. The material used during 1917 on this sewer was reinforced interlocking concrete pipe. The contract for the manufacture of the pipe was given to Blair & Co., of Woodstock, Ont., at $4.33 for 54-inch pipe and $3.44 for 48-inch pipe delivered along the trench.

The following table shows the lengths laid and cost per lineal foot of local improvement sewers laid from 1908 to 1917, the costs including interest:—

Year	Length in feet	Total cost	Cost per lineal foot	Percentage of average cost per lineal foot 1908-1917
1908	22,454	$ 65,841.66	2.93	102.3
1909	43,316	127,168.60	2.93	102.2
1910	25,925	51,840.47	1.44	50.2
1911	12,231	22,570.22	1.84	64.1
1912	13,960	39,603.28	2.84	98.9
1913	21,700	63,083.22	2.91	101.4
1914	57,200	84,417.20	3.13	109.1
1915	20,687	97,344.87	4.70	163.8
1916	4,359	19,967.72	4.58	159.9
1917	4,292	7,155.31	1.67	58.2
	236,124	$678,992.65		

Street Oiling

During the year, 9.3 miles of macadam pavement were treated with Tarvia at a cost of $8,260.55, and 33 miles were sprinkled twice with asphaltic oil at a cost of $13,898.56. Due to the fact that proper distributers were used on the second application of oil, the cost was $5,228.39 as compared with $8,670.17 for the first application.

Two Austin distributers, costing $300 each, were purchased and attached to the old sprinkling wagons, and besides using less oil they placed the oil in a more even manner. This oiling, besides having a beneficial effect on the roads, also eliminated the dust.

Street Cleaning

Two Mack-Hvass motor flushers, costing $7,815 each, were purchased and each operated for two nine-hour shifts throughout the season. These flushers replaced all but three horse-drawn flushers and besides being more economical kept the pavements in better condition. A reduction in street sweepers, due principally to the efficiency of these flushers, was made from 82 to 55 and the streets maintained in good condition.

Sidewalks

Forty-three sidewalks, having a total length of 2.3 miles, were laid at a total cost of approximately $20,400.

Waterworks

The redistribution system of large mains was finished in August and this had the consequent effect of increasing the pressure throughout the city. The new pumping station at Lemieux Island and overland pipes connecting up with this system also went into operation in November, and the Queen Street station used since only as a standby.

The consumption of water is about double what it should be for a city of the size of Ottawa, but it is the intention of the works department to carry out a general Pitometer survey to locate leaks and reduce this waste.

In 1917 the registered population inside the city limits was 101,549. The average number of Imperial gallons of water pumped daily was 20,938,162. The average daily consumption per capita of population was 206.1 gallons. A total of 183.8096 miles of pipe had been laid, an increase of only 1.028 miles during the year. There were 24,805 services, an increase during the year of 136. There are now 1,347 hydrants. The expenditure amounted to $373,285, or 4.88 cents per 1,000 gallons, while the revenue collected totalled $399,468.

Pitometer Survey

Work was commenced with the Pitometer in the latter part of September. The first district which was surveyed was Rockcliffe, and this part of the water distribution system was found to be wasting very little water.

Tests were then made of the water pipes crossing the Rideau River to New Edinburgh. The 15-inch steel main at St. Patrick Street bridge and the 8-inch main at Botelier Street were found to be in the best condition. The 8-inch main crossing at McTaggart Street, was found to have a leak in the river section wasting about 450,000 Imperial gallons a day. This main was completely cut off and will be repaired in the spring. Two of the valves on the 8-inch main at Sussex Street were found to be leaking very badly at the spindle. One valve alone was wasting slightly over 100,000 gallons. These valves are under water and will have to be repaired when the Rideau River water is low. Several leaks were discovered in W. C. Edwards' yards, and one on Sussex Street, which have not yet been repaired.

The apparatus was then moved to the Chaudiere section. The first main tested was the 8-inch Bronson Avenue pipe crossing the tail-race, and it was found to be wasting over 250,000 gallons per day. The leak was

located and repaired by the diver. The largest leak detected was found on the Montreal Street 8-inch main. This leak was wasting nearly a million gallons per day, and the main was immediately shut down.

The 8-inch Booth Street main to J. R. Booth's mills was found in bad condition, but we were unable to calculate this wastage, as we could not close the feed to the mills. This main should be replaced by a main slung to the bridge, as it will be impossible to repair any leak in the water section of the old 8-inch pipe.

With the numerous small leaks which were detected and repaired and the larger ones already described, a wastage of from 2,500,000 to 3,000,000 Imperial gallons per day was located and for the most part repairs were made. In 1918 it is intended that the pipes crossing the canal, Rideau River and parts of the Ottawa River will be thoroughly tested, besides all districts not covered in 1917.

GOVERNMENT TAKES OVER HALIFAX GRAVING DOCK

IN an announcement by Hon. C. C. Ballantyne, Minister of Marine and Fisheries, regarding shipbuilding prospects at Halifax, it is stated that the government has taken over the Halifax drydock. This dock was built by the firms of S. Pearson & Sons, of London, England, and S. M. Brookfield, Limited, of Halifax. It was subsidized by the admiralty, the Dominion Government and the city of Halifax, each of the three giving $10,000 a year for twenty years.

The site was selected by the admiralty on account of its proximity to the naval dock yard. Considerable rock excavation was necessary. A channel several hundred feet in depth had to be excavated into the harbor in order to give a clear entrance depth of over thirty feet. The dock was difficult and expensive to build. It was the first built in Canada, and is one of only two drydocks on the Atlantic coast in British North America, the other being at St. Johns, Newfoundland. Both of these docks were built about thirty years ago at the suggestion of the admiralty.

Until the "Calgarian" and the "Alsatian" were launched, the Halifax dock was large enough to accommodate any ship in the Canadian trade. It is 575 feet long, 102 feet wide at the top and 70 feet at the bottom, with 30 feet of water on the sill. British and French warships have been docked, also the "Indiana," an American battleship. Several vessels have been docked with cargoes on board. Among these was the "Bremen," 550 feet long; ship, coal and cargo weighing 17,300 tons.

The loss suffered by the dock due to the Halifax explosion was appraised at approximately $400,000. The dock itself received comparatively little injury, but all the buildings, such as coal sheds, pump house, boiler house, machine shop, engine house, etc., were destroyed. The dock was not used from December 6th, 1917, the date of the explosion, to February 22nd, 1918, but was again put into commission on the latter date, although all the broken machinery had not yet been replaced.

It is understood that the government intends to build another drydock at Halifax, one that will be able to take the largest dreadnought or Atlantic liner. It will be 1,000 feet long, 120 feet wide and 36 feet deep.

Since the Halifax dock was built, the government has become much more liberal in its assistance to docks by means of subsidies. The Montreal dock receives about $140,000 a year for 35 years. The Prince Rupert dock receives a smaller subsidy. The government built the first dock at Levis, and are now building a second. The government also built the first dock at Esquimalt and are building a second there. It is understood that St. John, N.B., is to be given a government drydock to be included in the terminal scheme for that port.

The Halifax drydock was owned by the Halifax Graving Co., Limited, of which S. M. Brookfield, a well-known citizen of Halifax, was president.

LETTER TO THE EDITOR

"Canadian Association of Engineers"

Sir,—Just an odd remark concerning the formation of the "Canadian Association of Engineers," reported in your issues of April 25th and May 23rd. It seems to me that an organization of this kind is not necessary outside of the Canadian Society of Civil Engineers, regardless of the fact that Mr. Goedike remarks in his "Letter to the Editor," published in your May 23rd issue: "This asscciation has been forced into existence by conditions as they have been in the past and are at present, and intends to carry on a progressive movement to meet conditions in the future as they arise to the best interest of the engineer."

Conditions as they have been in the society need not necessarily be adopted in the future if the same energy which has organized this association be extended to the society through the right of a thoughtful ballot in electing its representatives.

The purport of the general rules of the society from its inception, even to the inception of the Institution of Civil Engineers of the United Kingdom, one hundred years ago, is to ensure that the engineer's utmost skill shall be placed at the disposal of those who employ him, and that the method of his remuneration shall not involve any conflict between his personal interests and those of the clients whom he advises. This general rule no doubt holds good with the society, although it has been allowed to lie dormant by those who have been in control of affairs.

My personal idea of the matter is that every time an engineering club or association is formed outside the society, that act tends to weaken the society. I believe that all questions concerning engineers should be handled by the main Dominion-wide society, and that that society be made democratic by the weight of the ballot.

New clubs and associations mean additional fees, and, being unnecessary, in my estimation, are, therefore, a waste of money. Besides having pressure applied from two opposing groups within the profession, it will tend to weaken still more that little spark of confidence that the public at present holds for the engineer.

All engineers, I feel, are in accord with the four objects of the association, but probably would rather have the energy of the association applied to the Canadian Society of Civil Engineers.

E. L. MILES, M.Can.Soc.C.E.

Calgary, Alta., May 28th, 1918.

[NOTE.—We are in entire agreement with Mr. Miles' viewpoint, and his arguments are very similar to some of those used by the representative of this paper who attended the association's meeting and successfully urged the prospective members to suspend their meetings in order to give the new Institute a fair chance to show what it can do. The report of the suspension of the meetings, which appeared on page 472 of our May 23rd issue, has apparently escaped Mr. Miles' notice, although Mr. Goedike's letter, which Mr. Miles quotes, also appears in that issue, but upon another page.—EDITOR.]

SOME PHASES OF WORK IN THE DISTRIBUTION SECTION OF THE WATER DIVISION, ST. LOUIS*

By W. A. Foley

THERE are several distinct features of the St. Louis distribution system which do not usually obtain in other municipalities; principal among these may be mentioned the two distinct distributing systems called the high and low. The topography of St. Louis is such that the city maintains these two systems, the first termed high at 125 pounds pressure, the second termed low at 85 pounds pressure.

The low system comprises about 67 per cent. of the pipe mileage, and ranges in size from 3-inch to 48-inch, amounting to 680 miles, supplying approximately 35.4 square miles of area. This system supplies certain districts where the elevation does not exceed 100 feet above the city directrix. It was installed before the confining limits of the city were extended, when the city proper was located on the table land adjacent to the river.

As the city growth pushed forward it was essential that the out-lying districts be supplied with an adequate volume and pressure, and the topography of the land was such that an increased pressure system with high duty pumps had to be installed to meet the demand. The high-pressure district now comprising 330 miles of pipe was decided upon. This system supplies districts in which the elevation exceeds the city directrix by more than 100 feet, and is equal in area to 26 square miles. The two systems are separate and distinct, although there is contiguity in all the mileage, the pipe system being laid out on the gridiron theory. Each is maintained separate and independent of the other by means of valves, which close off one system from the other, thus maintaining the independent pressures. The valves are termed separation valves, being kept closed and tabbed with metallic disks showing the number of each valve and indicative of the valve being shut. In the event a metallic disk is not readily available the cap-nut of the valve is reversed or inverted, which is also indicative of a separation valve.

These valves are not opened except when necessity arises, and in this event the high pressure is allowed to bleed into the low system during the period the occasion demands. They are also opened during the semi-annual inspection of valves, which occurs in May and November, when all valves in the two systems are examined and worked to insure their thorough fitness for any subsequent operation, or as a relief to the crowding of the high service pumps, which occurs during the night, when a few separation valves are opened to relieve the load.

30 to 125 Pounds Pressure

Many of the consumers are so fortunately located that either high or low service is available for domestic supply. The low-pressure extremes range from 30 to 85 pounds, and the high-pressure from 40 to 125 pounds. The business section of St. Louis, being the oldest, is supplied by the low-pressure system, but ordinarily good pressure is obtained, the average for the commercial district, which comprises 483 city blocks or 2⅓ square miles area, being 45 pounds.

Another feature of the St. Louis distribution system is a 36-inch lock-bar steel main in 30-foot lengths with riveted joints 26,700 feet in length, which crosses the heart of the city, and acts as a carrier for either high or low-service feed. This feeder has its origin in the central pumping station and can be operated from an 85-pound head with a delivery of 750,000 gallons per hour, or from an 125-pound head with a delivery of approximately 1,000,000 gallons per hour. The change in this trunk line from high to low service is effected by the operation of a few hand-operated valves immediately in front of the engine house and two hydraulically operated valves at the terminus of the steel main, practically five miles distant, where it is breeched into both systems by means of a Y connection. In times of emergency or excessive draught, this feeder serves as a reserve or reinforcement of either system. Many other communities accomplish practically the same purpose by speeding up pumps in times of fire, but the St. Louis steel line was designed with the purpose in view of acting as a composite carrier on either system, as the need arose.

The essential necessity of present-day distribution is conservative despatch. Mechanical appliances to supplant slow hand labor and the execution of repair work with speed are the chief features of distribution work. Although all water distribution departments have features in common, with reference to the general work, yet each individual system has some little appliance or method of repair which is a special feature of that particular system.

Repair of Broken Mains

Portable pumps driven by air or gas, such as Los Angeles has in service, trench filling by cable drag or auto slip, have been employed in St. Louis, not by the exact method employed by other communities, but by methods which prove more feasible here. During the winter, when frozen soil conditions make the excavation for repairs of broken mains excessive in cost, the St. Louis department has found it practicable to use a blast pan, such as is employed by street repair gangs in asphalt surfacing. This proves an effective method of dissipating the frost and expedites the work of excavation, consequently effecting a saving of both time and labor. In the repair of mains 15 inches in diameter and larger where such repair necessitates the employment of a sleeve, the department finds it expedient to employ what is known as a sleeve-spacer. This simple device is the idea of a local street service foreman, and has proved of great value in such work. The spacer is a sort of turn-buckle affair, which is slipped into position and tightened, so as to prevent movement of pipe when the sleeve is slipped into place, but is serves an ideal purpose in spacing the sleeve so that an even joint can be run around the pipe circumference. Usually four of these spacers are employed in the repair of mains 30 inches in diameter and larger. This device is worthy of adoption, especially where repairs are made in close proximity to a valve and its subsequent closing with its large pressure surface may cause a creeping of pipe at the space where sleeve has been employed.

Constant attention to every detail is becoming absolutely essential for the maintenance of a modern pipe system. Air patrols to release air pockets, constant overhauling of valves and other appurtenances, and absolute attention are the prices demanded in a modern system. Conservation of water by the insertion of valves, so that no great loss of water will result from the scarcity of these necessary valves when shuts are enforced on a distributing system through broken mains, is essential. In St. Louis the practice of lengthy shuts for repairs was common until five years ago. These shuts are generally made in a residential district, and the inconveniences are many. Not

*One of a series of four papers presented before the annual convention of the American Water Works Association, St. Louis, May 15th, 1918.

only does the application of frequent valves mean a conservation of water, but it means inconvenience for fewer consumers, and the convenience of the consumer is the essential feature in water distribution.

Not only does the city of St. Louis study and apply all principles which tend to the betterment of the system, but the department maintains an intelligence bureau holding school for one week's duration twice per year. At these school sessions all employees of the distribution system attend, especially the newcomers, who are fully initiated in the art of cutting pipe, yarning and pouring joints, caulking, assembling hydrants and valves, rigging derricks, the use and names of various tools, and all other little details with which all distribution employees should be familiar. These sessions are generally attended by department engineers, and often the exchange of ideas proves as beneficial to the superiors as to the subordinates. The professor in charge is generally a graduate of the ditch, who has advanced step by step in the service, and is capable of showing the principle by actual demonstration. By teaching the employees the use of tools and allowing them to do the actual work in these practice sessions, the department has always on hand an adequate corps of capable men who can assume the different positions without crippling the service when the occasion demands. All large cities should adopt the idea as it familiarizes the employees with the different methods and use of tools, which proves of inestimable value to the department when "trouble-time" arrives.

CONSERVATION OF ENGINEERS

ENGINEERING COUNCIL, which is an organization representative of the five largest engineering societies in the United States, has forwarded an address and resolution to the United States secretaries of War and Navy, and also to the Provost-Marshal-General and to the members of the Senate Committees on Naval and Military Affairs, dealing with the conservation of technical engineers. The text of the address follows:—

Technical engineers of every branch of the profession who are taking part in the war activities of the army and navy are alarmed at the unfortunate waste of technical training caused by the drafting and enlisting of engineers for regular service with little or no regard for their technical attainments. These technically educated and experienced men are essential to the successful conduct of the war and cannot be replaced. There is continuing evidence that America is repeating in some measure England's mistake of sending technical men into the ranks when they should be carefully conserved for special duties in the fighting forces or on the technical staffs of the army, the navy and the essential war industries.

Thousands of Names Given to Government

These facts have been forced upon the attention of engineers who have been co-operating with the government through the Naval Consulting Board, the National Research Council and Engineering Council. Upon these organizations requests have constantly been made for engineers, chemists and other technical men for a great variety of military services. Thousands of names have thus been furnished to the government departments and bureaus. Engineering Council especially has devoted attention to this personnel work through its committee, known as American Engineering Service, which has available classified lists of approximately 25,000 engineers, and besides unclassified lists of many more. It is from these lists, directly or indirectly, that most of the names have been selected for war service.

Engineering Council was founded by the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, and other engineering societies are co-operating with it in this service, the total membership represented by these organizations being approximately fifty thousand. Already from 10 to 15 per cent. of the members of these several organizations are in the uniformed services of the country, and it is safe to say that a large majority of their remaining members are in the government civilian service, or otherwise directly or indirectly engaged in the war. Engineers do not seek to avoid fighting, but earnestly desire to be given opportunities for fighting and other services in which they can be most effective and which cannot be performed by others.

It is known that through the Committee on Classification of Personnel in the War Service Exchange (of the War Department) and some other ways, efforts are being made to counteract the tendencies toward the loss of our technical men in the ranks of the army and navy. It is believed, however, that these efforts are insufficient and that they should at once be supplemented by other stringent measures dealing with the subject in the draft boards and recruiting stations.

Resolution Offered

In view of the foregoing, Engineering Council, created to provide means for united action and to speak authoritatively for its member societies on all public questions of common interest to engineers, respectfully offers the following:—

Whereas technically trained engineers are indispensable to the army, the navy and the war industries, in engineering corps, ordnance bureaus and signal corps, in aviation, submarine and tank service, in shipbuilding, and in many other assignments; and

Whereas through draft and otherwise, many of these irreplaceable men have been and are being diverted so that their special qualifications are not being utilized; be it

Resolved that in the opinion of Engineering Council, technically trained men of all ages should be enrolled and conserved for technical duties and special efforts should be made immediately by the War and Navy Departments to find and record such men among drafted and enlisted forces and to assign them to places in which their special qualifications are needed; and be it further

Resolved that Engineering Council offers to assist the War and Navy Departments in locating and classifying such men, if its assistance be desired, provided these departments will give the necessary facilities for collecting information about engineers now in the army and navy, or whose names are upon the selected draft lists.

These resolutions are offered solely in a patriotic spirit of helpfulness.

(Signed), Alfred D. Flinn, secretary, Engineering Council.

The eleventh annual meeting of the Canadian Gas Association will be held in Montreal, P.Q., August 22nd and 23rd, 1918. War time problems of the industry will be the main topics for discussion.

In an address to the National Coal Association at Philadelphia, Joseph Dickson, chairman of the anthracite committee, of the United States Fuel Administration, stated that Canada's allotment of anthracite coal for the coming season is 3,602,000 tons, compared with 3,856,021 distributed last season.

The Canadian Engineer

Established 1893

A Weekly Paper for Canadian Civil Engineers and Contractors

Terms of Subscription, postpaid to any address:

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

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

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

HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1208 McArthur Bldg., Winnipeg. G. W. GOODALL, Mgr.

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TORONTO AS A RAILWAY CENTRE

UNDER the above title, the "Toronto Globe" in a recent issue published an editorial urging the Dominion Government to establish the national railway headquarters at Toronto. That city has always been the headquarters of the Canadian Northern Railway, and it would throw many of its citizens out of employment were the headquarters of that road to be moved elsewhere. There is also a great deal to be said in favor of the Globe's argument that Ontario and the West are more favorable to public ownership than are Montreal and the East, and that public sentiment would be advantageous in promoting the interests of state railways, were the headquarters of the latter to be located in Toronto.

On the other hand there are equally strong arguments in favor of Montreal as the headquarters for the national system. If the Grand Trunk Railway be taken over and merged with the Canadian Northern and the Canadian Government Railways, as appears to be the government's intention, more people in Montreal would be thrown out of employment by moving the Grand Trunk headquarters to Toronto, than the number who would suffer by the removal of the Canadian Northern Railway offices to Montreal.

Moreover, the headquarters of the Canadian Pacific Railway will undoubtedly remain at Montreal for many years to come, and it would be very convenient in many ways to have the headquarters of the big privately owned and the big publicly owned system in the same city. Not only would it prove a convenience to everyone who wished to do business with the two systems, but what is more important, it would be very convenient for the officers of the systems, who would undoubtedly have a very large amount of detailed business to transact with each other daily. Montreal also possesses many other natural advantages as a centre of railway activity, chiefly the fact that it is Canada's main port; railway executives must keep in close touch with shipping.

The "Globe's" editorial is probably the first gun in a battle between Montreal and Toronto for the headquarters of the new national railway system. If the government moves the Grand Trunk from Montreal, it will have to face strong protests from that city. If it moves the Canadian Northern, it will have to deal with equally irate deputations from Toronto. To steer a middle course, the government may establish the headquarters at Ottawa. We have reason to believe that there is a strong tendency on the part of some of the officials of the Canadian Government Railways to advocate the removal of their headquarters from Moncton, N.B., to Ottawa. With the growth of that system, and especially with the taking over of the Canadian Northern, Moncton becomes impossible as a railway centre. Should the move be to Toronto, Montreal or Ottawa?

CHLORINE IN SANITARY SCIENCE

SANITARY science has unquestionably been benefited to a very great extent by the discovery of the uses and accomplishments of chlorine compounds. The curves accompanying the article on "Chlorination," by Mr. C. A. Jennings, published in this issue, prove that chlorine has been a powerful weapon in the fight against typhoid. Mr. Jennings does not attribute all of the reduction in typhoid fever death rates to the use of chlorine for the disinfection of water supplies, because sometimes other preventative sanitary measures have been adopted at about the same time; such measures, for instance, as the pasteurization of the milk supply, the elimination of privy vaults, the following up of typhoid cases to determine their cause and to prevent secondary infections, and swat-the-fly campaigns. Nevertheless, the proper filtration and disinfection of water supplies has certainly been by far the greatest contributing factor in the remarkable reductions in the typhoid death rate which are shown by Mr. Jennings' statistics.

COMPETITION AFTER THE WAR

WHETHER there will be a war after the war, lies in the lap of the gods. Free-trade England is not quite so wedded to Cobdenite theory as in ante-bellum days, and is disposed to carry on an economic offensive against the Central Powers after the signing of peace. The United States has within recent months taken over alien enemy property of a corporate or business character, including the mines, timber limits, wharves and shipping owned by German corporations and individuals. Both the United Kingdom and France realized too late the hold that German finance had secured on vitally important national enterprises; and in both nations, notably in France, there is a determination that German capital with its programme of "peaceful penetration" must not be

given the opportunity to aggrandize itself and ever again place national interests in danger.

Fortunately for Canada, the chief capital investments in this country were made by the United Kingdom and the United States. From the Motherland and the Republic, capital will come in the years succeeding the war according to the Dominion's necessary requirements; and, needless to say, such investments will be welcomed. It is only natural, however, to expect that the Dominion will set its face against any policy of economic penetration that Germany may attempt on this side of the water. Whether the brutality and arrogance of the Central Powers will compel the Allies to create an economic combine against them, in self-defence, has yet to be determined; but it is evident that world-wide competition, in any event, will be keener after the war than has ever been experienced before.

Canadian and American manufacturers have yet a great deal to learn from Germany with regard to the efficient marketing of their products. And still in another particular, hardly less important, Germany has surpassed the world in the sphere of industry and commerce; attention to detail lifted German industry to its important position; and it is that same attention to detail that has permitted the enemy to survive, unfortunately, so long as he has done.

It may be admitted that in the great standardized industries of Canada and the United States, the main economies have been effected; but certain details in achieving economies have been overlooked—economies that may make all the difference between success and failure in the fierce competition that will ensue at the close of hostilities. It is wise to increase one's economic knowledge, even if the lesson be taught by the vilest enemy.

It is patent that many small economies can be effected, both in shop and office—by the keeping of fewer and better records in the office, by the avoidance of duplication, and by so organizing the work that computations need not be undertaken again and again for the same kind of job. And in the shop, chemical analyses of metals will perform wonders in reducing the costs of manufacture; castings in the foundry may be made smaller and so require less finishing; designs and costs may be worked out with greater detail and care. The truth is that, in many Canadian and American plants priding themselves on their output, only the rudimentary work of organization has been carried on. Filing systems have become obsolete; there is unnecessary and wasteful shifting of men on jobs, the natural breaks in the work, at noon and morning, not being regarded; and, much more, there is no full utilization of machinery.

In many industries there is a "slack" season for both workers and machines, a slowing down in the process that makes for the waste of both capital and labor. By efficient planning it is often possible to carry over jobs for such slack periods, just as the progressive farmer makes work for rainy days. Some managers, in factories turning out standard products, install machinery with a view to its utilization in dull time on other types of work. This is important when markets are narrow for the main output. Moreover, by the use of high-speed tools, by reducing time wasted between jobs, by the full utilization of the equipment, important economies in labor may often be achieved.

Hon. J. A. Tessier, Minister of Roads, recently made a tour of inspection of the highway between Sorel and Montreal to investigate the claim for proposed changes made by residents of that district.

PERSONALS

C. J. Brittain, manager of the Winnipeg branch of Canadian Fairbanks-Morse Company, Limited, has been elected to the directorate of that company.

F. P. Knopp has resigned as shop superintendent of the bridge department of Canadian Allis-Chalmers, Ltd., Toronto, to take charge of two ways for the Submarine Boat Co. at Newark, N.J.

Herbert J. S. Dennison, the well-known patent attorney, of Toronto, has moved his offices from 18 King Street West to the Kent Building, corner Yonge and Richmond Streets, Toronto.

Llewellyn N. Edwards has resigned from the works department of the city of Toronto and has reported for service at Camp Lee, Petersburgh, Virginia, having received a commission as captain in the engineering reserve corps.

James C. Johnstone, former city engineer of Port Alberni, who is now with the 1st Canadian Pioneers, and who has on several occasions been promoted, has recently received appointment as major.

John J. Scallon, for many years general superintendent of the Davenport Works of Canadian Allis-Chalmers, Limited, Toronto, and previously of the Canada Foundry Co., has been appointed manager of hull construction for the Submarine Boat Co., of Newark, N.J. This new plant will have fifty ways, of which about thirty are completed and have keels laid.

F. J. Brule, assistant general manager of the British American Nickel Corporation, has transferred his office from Sudbury, Ont., to Deschenes, P.Q., where the new plant of the corporation is being erected. With Mr. Brule there have been transferred the following engineering staff: D. Van Doren, chief engineer; Louis Whitman, office engineer; C. D. Norton, field engineer; and R. Guy, draftsman.

A. W. Haddow, who has filled the position of acting city engineer for Edmonton, Alta., since the retirement of the late A. J. Latornell, has been appointed by the city commissioners to the post of city engineer. Mr. Haddow's home is in Simcoe, Ont. He went to Edmonton in 1909, having previously been connected with an engineering firm in Northern Ontario. In 1911 he was appointed assistant city engineer, and in July, 1915, was given the position of acting engineer.

Lieut. H. N. Darling, of Toronto, Ont., who went to France with the first Canadian Pacific Railway Battalion of Railway Construction, has been awarded the Military Cross in recognition of his bravery and devotion to duty in saving a large amount of valuable railway equipment during the operations around St. Quentin in the early spring. Lieut. Darling was the first of his battalion to be promoted to a commission and the first of his unit to be awarded the Military Cross.

OBITUARY

Michael Chapman, formerly of Chapman & Walker, of Toronto, died in France recently. Mr. Chapman took the officer's training course in 1915 with the Royal Grenadiers and later obtained a commission with the Grenadier Guards in England. He leaves a widow and two young children.