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FUNCTIONAL *versus* GEOGRAPHICAL PLAN OF ORGANIZATION

WITH PARTICULAR REFERENCE TO STREET CLEANING DEPARTMENTS—FUNCTIONAL PLAN RESULTS IN BETTER ADMINISTRATIVE CONTROL BUT THERE ARE OBJECTIONS.

By T. L. HINCKLEY,
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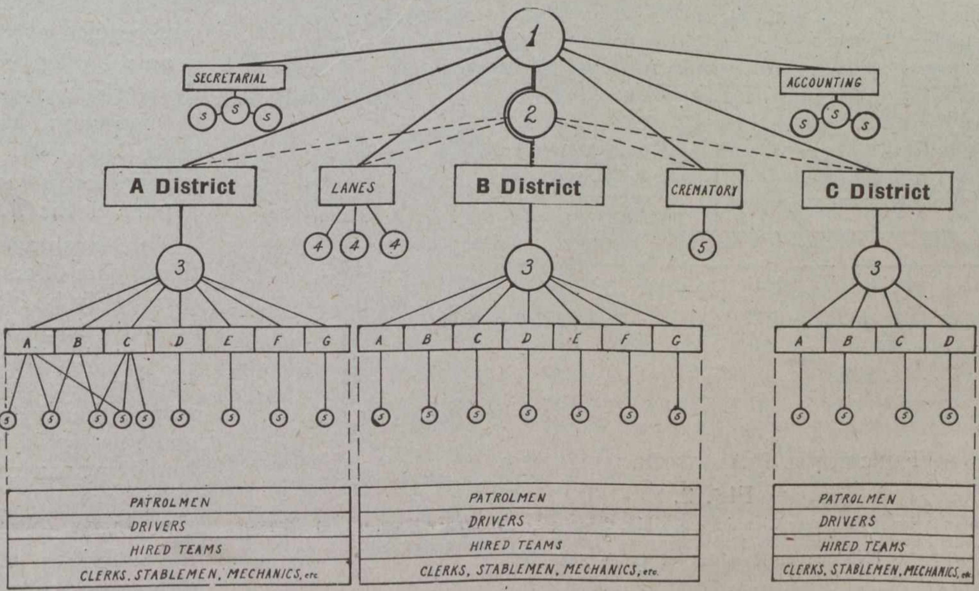
IN listing the various arguments for and against a suggested functional arrangement for street cleaning activities—including refuse collection—the usual type of organization has been assumed. Thus the municipality is presupposed to be districted for the purposes of the department into several separate areas, in each of which all street cleaning, refuse collection and allied duties are performed under the supervision of a general foreman.

The application of the functional plan, in this case, consists in separating the operations having to do with street cleaning from those having to do with refuse collections, and in placing at the head of each specialized activity a special supervisor,* the various separate district organizations being merged into two city-wide organizations—one for each function. It is also planned that matters having to do with equipment shall be entrusted to a third special supervisor of equipment, thus permitting both the street cleaning and the scavenging supervisors to devote their time wholly to the actual field inspection of their respective functions.



GEOGRAPHICAL PLAN OF ORGANIZATION.

Fig. 1.

Reference Numbers—1, Commissioner of Street Cleaning; 2, Chief Inspector; 3, Superintendent: of Division in Fig. I., of Function in Fig. II.; 4, Lane Inspectors; 5, Foreman of Subdivision; 6, Members of Office Staff.

Advantages of Functional Plan.

The advantages urged on behalf of the functional plan of organization are: (1) Better administrative control; (2) greater opportunity to develop improvements; (3) more accurate knowledge of the cost of work done; (4) greater opportunities to effect retrenchment.

1. The functional plan provides for better administrative control, because:

It makes one man responsible for each branch of the work instead of distributing responsibility for a part of each branch between three men.

It focuses all the activities of the department in one central office, thus making it possible for the department head to get information about all branches of the work without loss of time or waste of effort.

It promotes co-operation between the different branches of the service and develops a clearer understanding of the department's problems.

It enables the entire city to be treated as a unit, thus discouraging duplication—especially in regard to equipment and in regard to records and accounts.

2. The functional plan gives greater opportunity to develop improvements in service, because:

It concentrates the attention of each supervisor upon one feature of the work, and allows continuous thinking and planning along definite lines.

It tends to make each supervisor an expert in his special field, and to build up the work of his division on the basis of expert knowledge.

It prevents waste of time and lost motion because of having to shift from one piece of work to another.

3. The functional plan allows for more accurate information as to costs, because:

*This does not necessarily mean that subordinate foremen would no longer be needed. They would be needed, but the "districts" under the functional plan would be different from the present districts.

It separates the various activities from each other, and allows each to be treated as a unit.

It creates natural channels for the transmission of reports, cost data, etc.

It does away with intricate bookkeeping now necessary in order to properly distribute cost data.

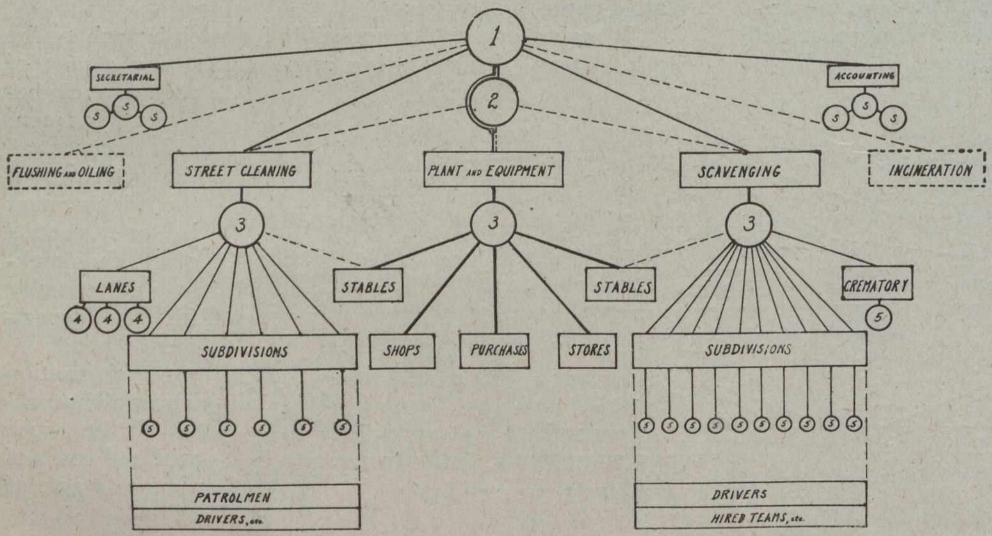
4. The functional plan offers many inducements for lowering costs, because:

With more accurate knowledge as to costs it is easier to locate the cause for excessive costs, should they exist.

In fixing attention upon the work to be done, rather than upon the area in which it lies, details of operation are given more importance than under the present scheme, thus increasing the chances to introduce economies in method.

Summary of Objections to Functional Plan, with Comment.

1. Flushing on a city-wide basis cannot be conveniently handled under the functional plan. Flushing equipment will be left once or twice each week at one end of



FUNCTIONAL PLAN OF ORGANIZATION.

Fig. 2.

Reference Numbers—1, Commissioner of Street Cleaning; 2, Chief Inspector; 3, Superintendent: of Division in Fig. I., of Function in Fig. II.; 4, Lane Inspectors; 5, Foreman of Subdivision; 6, Members of Office Staff.

the city and would have to be taken to the other in order to begin work again. This represents lost time and expense.

Comment: This objection would apply under any system of organization, including the customary, or geographical type. Investigation might show that some other arrangement for flushing on a city-wide basis is possible, which would not involve leaving all the flushing equipment at one end of the city once or twice a week.

There is also the problem of storage and location of equipment. The functional plan, by requiring one man to devote his whole time to matters of stores and equipment, insures continuous study and planning along this and other similar lines—something which is not possible under the present system, except for the commissioner.

2. There is better supervision of street car flushing under the geographical type of organization. Each division superintendent has only a portion of the flushing area to inspect and will consequently give more time to it than when the area to be supervised comprises the entire city.

Comment: Street car flushing is largely a matter of proper routing of machines. Once in service, a machine must keep going; and with a city employee attached to each unit, as is customary, chances of falsifying records of areas flushed are small.

Supervision of these machines consists chiefly in seeing whether the routes are being followed as mapped out—a fact which can be determined as well by a street cleaning inspector on a motorcycle as by a division superintendent.

3. Supervision of patrolmen* is more thorough under the usual system than would be possible under the functional plan. Each district foreman customarily gives a part of his time to supervising the work of patrolmen, as well as that of the scavengers, culvert cleaners, or other employees of the department. This would not be done if scavenging foremen, for example, paid attention only to collecting and hauling refuse.

Comment: It is true that supervision of patrolmen under the functional plan would be taken away from foremen of scavenging work. Such supervision, however, is not regular under the geographical distribution of work, but depends on how much time the general foreman can spare from his other duties.

Under the functional plan, street cleaning inspectors on bicycles or motorcycles, would be able to visit a patrol often enough to see how the work was being done. Liability to inspection at any time should serve as well, for purposes of supervision, as actual inspection for a part of the time.

The advantage which the functional plan offers is that there must necessarily be *closer* supervision of *all* activities. A somewhat larger area could also be covered by a foreman of scavenging, for example, than by a general foreman, and this would balance the cost of employing special street cleaning inspectors.

4. Costs would be increased by the functional plan because of additional foremen for street cleaning.

Comment: This is discussed in the preceding section. Actual study of cases where general foremen have charge of all activities within their districts shows that as between street cleaning and refuse collection, or scavenging, the latter is the more exacting work. Nevertheless, some time is usually given by general foremen to inspection of the men working on the streets. By combining, for street cleaning purposes, a number of the geographical districts and placing them under a special street cleaning foreman—mounted on a bicycle or motorcycle—the same amount of inspection would be given continuously by one foreman which is now, at odd intervals, given by a general foreman. Not only this, but the areas supervised by each scavenging foreman could also be correspondingly *increased* and the *net* number of foremen, and hence the *net* cost of supervision, would be no more than at present. (It may be added that actual tests have shown the correctness of this reasoning.)

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*i.e., "white-wings."

Objections Relating to Scavenging.

1. In order to handle refuse collections properly teams must be interchangeable.* This will be interfered with by the functional plan.

Comment: No trouble should arise over this point. All that is necessary will be to rule that in case of insufficiency of teams, scavenging has the preference. This will prevent friction between the foremen and allow teams to be interchanged.

With the introduction of a motor pick-up service for street sweepings any troubles due to interchanging teams will largely disappear. Eventually, the collection of street sweepings by horse-drawn wagons should be confined to light traffic streets.

2. Quantities to be collected vary so much that it is impossible to plan the work ahead of time, as the proper use of the functional method demands.

Comment: There will always exist a variation in quantities of refuse to be collected. The difficulty is met usually by hiring private carts when there is an excess and releasing them when no longer needed, and there is no reason why this could not be done under the functional plan.

The only difference will lie in the fact that, under the ordinary plan, all general foremen must make these adjustments for themselves, whereas under the suggested plan there would be but one responsible head. Under proper management this should represent a gain in administrative control.

Objections Relating to Plant and Equipment.

1. The customary practice of having one man in absolute charge of a stable allows greater flexibility than where authority for the use of teams has to come from a central office.

Comment: This will not be true if it is understood in advance that in case of an insufficient number of teams, the scavenging work has first choice. A street cleaning foreman, finding that some of his wagons will be needed for scavenging, will be able to notify his chief and arrange for hired teams before nuisance is caused.

This is not the only point. As stated above, motor trucks will probably take over the collection of all street sweepings within the next few years in all progressive cities. This will free the street cleaning branch from any dependence whatever upon teams, except in emergencies.

Conclusion.

Review of the foregoing shows that the objections raised against the functional plan are, for the most part, not serious enough to damage the main arguments in its favor, which are: (*a*) Centralized, responsible administration on a city-wide basis; (*b*) opportunity for detailed study and continuous planning along definite lines; (*c*) provision of natural channels for cost accounting data, with consequent increase in cost knowledge and a greater chance to reduce expenses.

Those familiar with municipal work will doubtless ask whether the demands of the functional plan are not too severe for the average type of employee secured for street cleaning and scavenging service—and whether the adjustments it requires can be effected without friction among a personnel already used to present methods.

As to the demands made by the change from a sectional to a functional basis of work, commonsense would suggest that any change so fundamental as this should be made by easy stages—first functionalizing each district, or a group of districts, and thence proceeding to the merging upon a city-wide basis. As to friction in making the necessary adjustments, there does not seem to be anything inherent in the functional plan which can not be handled by a competent administrator with the use of ordinary tact and patience. Making the change by degrees, instead of all at once, should overcome this trouble as well as the first.

*It is assumed (see introductory note) that the stables are used jointly by street cleaning teams, refuse collectors, etc.

EFFECTS OF EXPOSURE ON TAR PRODUCTS.*

By Charles S. Reeve, and Benjamin A. Anderton,
Office of Public Roads and Rural Engineering, Washington, D.C.

It has been shown on several occasions that changes occur in bituminous materials on exposure to the action of air and sun. Such changes are not due merely to the volatilization of lighter oils, but also to chemical changes in certain constituents of the bitumen, such as molecular rearrangements, inter-reactions, and oxidation. Changes of such a nature were demonstrated in the case of native asphalt and petroleum products by abnormal increases in the percentage of bitumen insoluble in paraffin naphtha, and in the case of tars by abnormal increases in the percentage of free carbon.

The present study was instituted for the purpose of extending the work through a greater range of tar products and to determine what relation, if any, existed between the changes brought about by exposure and those produced by laboratory distillations.

Seven samples were chosen, including two refined coal-tars, one refined water-gas tar, one refined mixed tar, two tar-asphalt mixtures, and one crude coke-oven tar. The results of the usual examination made according to methods published in Bulletin 38[2] of the Office of Public Roads, United States Department of Agriculture, are given in Table I. In addition, a dimethyl-sulphate test as described in United States Department of Agriculture Bulletin No. 314 was performed on distillates from the two tar-asphalt preparations.

Briefly stated, the method of procedure was as follows: Samples of each material were exposed to the action of sun and air for three months, which the previous investigation seemed to indicate was sufficient to bring about the maximum changes desired. Examinations were made at the end of each succeeding month to determine the change in weight and extent of hardening. In order to compare the effect of exposure with straight distillation, distillations in an Engler flask were made on each sample to produce a residue corresponding, in percentage by weight of the amount taken, to the residue produced on exposure, and the consistency of the residues thus produced was determined. Changes in the samples due to volatilization or other causes were noted by estimation of the percentage of material insoluble in carbon disulphide in the various residuums.

The box used for exposure tests was made of ¾-inch wood and had interior dimensions of 25 by 14½ by 2 inches. This was covered with a plate of ¼-inch plate glass resting on a strip of thick felt fastened to the sides of the box so as to make a tight joint and exclude all dust. Slots ¼ inch wide were cut through each side of the box, and to prevent the entrance of rain these were

*Abstracts from a communication by Logan W. Page, Director, Office of Public Roads and Rural Engineering, Washington, D.C.

protected by a thin board extending from the rim at an angle of about 45 degrees. Cotton batting was packed under this board against the slots to exclude dust from the outside air.

To approximate the constant circulation of air over bituminous materials exposed to actual service conditions, a current of air taken from a pressure pump and passed through a water wash-bottle to remove dust was introduced through a glass tube which passed through one of the slots and terminated at the centre of the box. This constant current of dust-free air tended also to keep dust from entering the box, and at the end of three months the clean, glossy surface of the harder samples demonstrated that practically no error had been introduced by contamination with dust.

The samples to be exposed were placed in Syracuse watch-glasses having depressions approximately 47 mm. in diameter and 8 mm. deep. Four specimens of each of the seven samples were prepared by accurately weighing 12 gms. of bitumen into a tared watch-glass, thus insuring practically a uniform depth of material for each specimen. The twenty-eight specimens were then symmetrically arranged in the exposure box in four rows, so that the four of each particular sample were equidistant from the centre of the box and the inlet of the air current. A thermometer was placed in the middle and the box set lengthwise on a shelf outside a window having an open southern exposure. The box was exposed in the late afternoon of April 21.

The next morning at 9 o'clock it was noted that brilliant white flaky crystals of naphthalene had formed on the under side of the glass. The temperature recorded in the box at this time was 35° C., but this gradually increased, and the crystals began to melt to a colorless oil.

At the expiration of one month's time all the specimens were removed from the box and weighed to determine their loss in weight for each set for this time. Three sets were then replaced in the box for continued exposure in the same position they had previously occupied, while the fourth was subjected to tests to determine its consistency and percentage of free carbon. The consistency was determined by float tests at 100° C., a temperature which it was felt would be sufficiently high to provide for a satisfactory test on later samples, and also by penetration tests at 25° C., 100 gms., 5 seconds, when the material was sufficiently solid to permit it.

The above procedure was repeated at the expiration of the second and third months. At the end of each month an irregular deposit of a red, gum-like substance, previously noted by Hubbard and Reeve, was found on the under side of the glass cover. Each time, before the cover was replaced, the gum, which is partially soluble in ethyl alcohol, but almost insoluble in carbon disulphide or benzol, was removed.

Allowing for some experimental errors, it is evident that the organic matter insoluble in carbon disulphide increased gradually. Throughout the present discussion this organic matter has been referred to as free carbon, although it is not unlikely that it may be partially composed of alteration products of tar distillates similar to the gum-like substance formed on the glass cover of the exposure box.

Table I.—Analyses of Samples Used in Exposure Tests.

Material	Refined coal-tar	Refined mixed tar	Crude coke-oven-tar	Refined coal-tar	Tar-Asphalt mixture	Water-gas tar preparation	Refined water-gas tar
Sample number	3896	4797	5123	5627	5992	6672	X
Specific gravity 25°/25° C.	1.215	1.244	1.206	1.256	1.177	1.126	1.184
Float test at 32° C.	1' 5"	.....	.....	.....	1' 30"	.....	.....
Float test at 50° C.	.....	4' 29"	.....	2' 16"	42"	.....	2' 21"
Viscosity Engler, 50 c.c. at 50° C.	.....	.....	.....	.....	.....	29.8	.....
Bitumen soluble in CS_2	.....	82.79	91.16	70.29	85.35	97.40	99.23
Free carbon	19.36	17.13	8.77	29.65	14.57	2.47	0.72
Inorganic matter soluble	.....	0.08	0.07	0.06	0.08	0.13	0.05
	.....	100.00	100.00	100.00	100.00	100.00	100.00

Distillation	Per cent. by volume	Per cent. by weight	Per cent. by volume	Per cent. by weight	Per cent. by volume	Per cent. by weight	Per cent. by volume	Per cent. by weight	Per cent. by volume	Per cent. by weight	Per cent. by volume	Per cent. by weight	Per cent. by volume	Per cent. by weight
Water	0.0	0.0	0.0	0.0	1.0	0.8			Trace	Trace	0.0	0.0		
First light oils (to 110° C.)	0.2	0.2	0.0	0.0	0.4	0.3			0.3	0.2	0.6	0.5		
Second light oils (110°-170° C.)	3.2	2.5	0.4	0.3	2.0	1.7			0.6	0.4	1.9	1.6		
Heavy oils (170°-270° C.)	29.6	25.1	23.2	18.8	14.0	12.3	Not made		18.2	15.6	21.4	18.8	Not made	
Heavy oils (270°-315° C.)	....	....	....	....	7.9	6.9			9.7	8.5	14.5	13.1		
Pitch residue	*67.0	*72.0	*76.4	*80.4	74.7	77.6			71.2	74.6	61.6	65.9		
Total	100.0	99.8	100.0	99.5	100.0	99.6			100.0	99.3	100.0	99.9		

Dimethyl Sulphate Test:

Per cent. insoluble (270°-315° C. fraction)	1.25	7.5
Per cent. insoluble (315°-350° C. fraction)	12.5	10.0
Per cent. insoluble (350°-375° C. fraction)	28.5	7.5

* Distillation made by old method (to 270° C.)

Recent investigations of Korea's iron mines have led to the prediction that they can be made to supply all domestic demands, and in addition supply Japan with 1,000,000 tons of metal annually.

With the object of promoting economic relations between the Entente Allies after the war, the City Council of Bordeaux, France, has announced itself in favor of plans now being worked out for a direct railroad between Bordeaux and Odessa, Russia. The line would pass through Lyons, France, Turin and Milan, Italy, Trieste and Belgrade. It is proposed to form a committee of delegates from the principal French cities interested in the project to push the plan.

The Canadian Fairbanks-Morse Co. has opened a branch sales office at Windsor, Ont., in order to take care of its business in Western Ontario. J. N. Charles will be in charge of the office.

The Engineering Society of the University of Toronto, at its regular meeting held on November 1st, welcomed 12 of its old members, who have returned recently from active service in France. Mr. Joseph Bannigan, President of the Engineering Society, acted as chairman, and Dr. R. A. Falconer, President of the University of Toronto, and Dean Ellis, of the Faculty of Applied Science, were present to give official words of welcome to the returned soldiers.

THE STRENGTH OF CLAMPED SPLICES IN CONCRETE REINFORCEMENT BARS.*

By E. L. Lasier.

CONCRETE reinforcement bars are received in lengths varying up to about 60 ft. The length most commonly selected, however, is in the neighborhood of 30 ft.; hence, it is frequently necessary in practice to lay one bar over another. It is also desirable upon more or less frequent occasions to secure a splice capable of withstanding a greater tensile stress than that which a plain lap splice of equal length could resist. In such cases U-bolt clamps, such as are ordinarily used in fastening wire cables together, have been successfully employed.

Three years ago such conditions confronted the designers of the wheel chambers of the State Line Power Plant of the Hydro-Electric Co. of West Virginia, on Cheat River near Cheat Haven, Pa. The wheel chambers were of the horizontal scroll type, designed to supply water to vertical, single-runner, 12,000-h.p. turbines, operating under an average effective head of about 81 ft., and were unusually large.

The wheel chambers were to be constructed of reinforced concrete, and it was decided to use U-bolt clamps where splices of reinforcement bars were necessary. The meagreness of published data on the subject prompted the investigation herein reported by the writer, who at the time was engineer of tests at the State Line development. This scantiness of available data, combined with the feeling that such information might be of value to engineers, also suggested the preparation of this paper. Its presentation has the approval of Mr. F. W. Scheidenhelm, consulting engineer, and chief engineer of the Hydro-Electric Co. of West Virginia. Mr. George F. Rowell was engineer-in-charge at the State Line development.

Scope of Investigation.—The tests were divided into three groups. In the first group, two reinforcement bars forming a "lap splice" with two U-bolt clamps were tested. Secondly, tests were made of two bars placed with the end of one butted against the end of the other, each clamped by the two U-bolts to a splice bar overlapping each of the main bars, thus forming what will be referred to as a "butt splice." These butt-spliced specimens were prepared and tested in order to avoid, at least partly, the eccentricity of loading resulting in testing clamped lap splices. It was thought that by so doing higher values of load at first slip, and larger maximum loads which the splices would resist, would be obtained; the opposite, however, as will be seen later (Tables III. and IV.), was the case. In these first two groups, the bars were not embedded in concrete. Thirdly, two bars, forming a lap splice, with two U-bolt clamps, were embedded in a block of concrete and tested.

Materials.—Complete data regarding the properties of all of the materials involved will be given, to permit an intelligent study of the tests.

The reinforcement steel consisted entirely of 1-in. square, cold-twisted bars. The specifications of the society for steel reinforcement bars, adopted June 1, 1912, as well as the present ones for billet-steel reinforcement bars, cold-twisted, were all fulfilled. Results of mechanical tests upon six specimens of the steel bars are given in Table I.

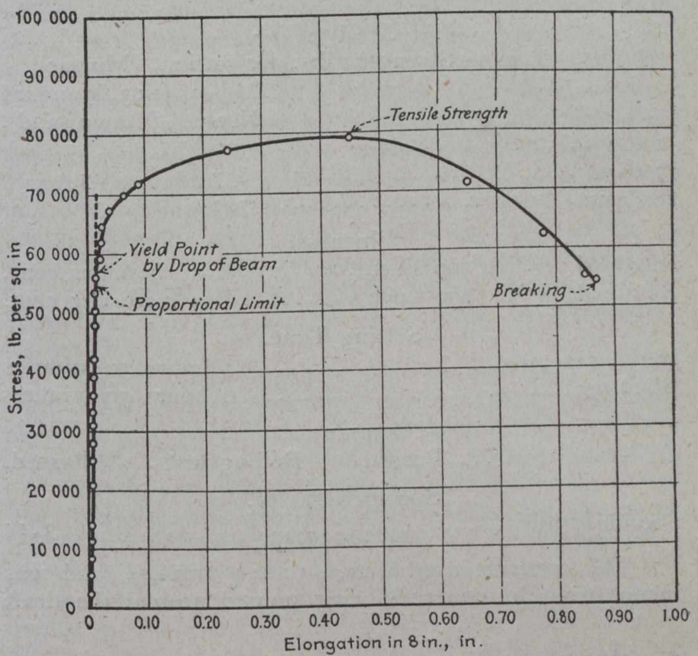

Fig. 1.—Stress Deformation Curve for Specimen No. 4.

The average values of yield point and tensile strength as recorded in Table I. will be used as a basis for obtaining the efficiency of the U-bolt clamped splices, rather than the values given for specimens Nos. 3 and 4. It is of interest to note in passing that the latter values, with a single exception, are larger than the values for specimens Nos. 1 and 2, in about the same proportion as that found by Messrs. E. P. Withrow and L. C. Niedner in their work on the effect of reducing the area for tension tests of reinforcement bars.

Table I.—Mechanical Tests Upon Reinforcement Bars.

Specimen No.	Description of Specimen.	Sectional Area, sq. in.	Yield Point (Drop of Beam), lb. per sq. in.	Tensile Strength, lb. per sq. in.	After Fracture. Elongation in 8 in., per cent.	After Fracture. Reduction of Area, per cent.	Appearance of Fracture.
1	Original form	1.0	63,670	71,370	....	....	Silky.
2	Original form	1.0	57,050	74,000	....	....	Silky.
Average			60,360	72,685			
3	Turned-down section	0.738	68,300	78,100	11.5	54.8	Cup-shaped; silky.
4	Turned-down section	0.710	57,000	78,830	10.9	53.4	Cup-shaped; silky.

NOTE.—In the cold-bend tests, specimens Nos. 5 and 6 were bent 180 deg. about a pin 3 ins. in diameter, without signs of flaws.

The stress-deformation curve of specimen No. 4 is shown in Fig. 1.

The U-bolt clamps used were all steel clamps, ⅝ in. in diameter, with the following dimensions: clear opening, 1⅜ by 2½ in., size of steel cross-piece, 4¼ by 1½

*Abstract of paper read before the American Society for Testing Materials.

by 7/16 in., length of threads, 1¾ in. One-inch square nuts were used. Each clamp complete with nuts weighed 1¾ lbs.

Table II.—Analysis and Tests of Cement Employed.

Analysis.

SiO_2, per cent.	22.76
R_2O_3, per cent.	9.78
CaO, per cent.	61.36
MgO, per cent.	1.80
SO_3, per cent.	1.58
Loss on ignition, per cent.	1.76

Physical Tests.

Tensile Strength, lbs. per sq. in.	Neat.	Mortar (1:3, standard Ottawa sand).
1 day	306	...
7 days	637	239
28 days	762	386

Fineness.

Retained on No. 100 sieve	7.6 per cent.
Retained on No. 200 sieve	24.6 per cent.

Setting Time.

Initial set	4 hours 30 minutes
Final set	6 hours 50 minutes

Soundness.

Cold-water test ....Passed. Boiling test .....Passed.

Specific Gravity.

Specific gravity 3.14

The concrete used was a 1:2:4 mixture, and was taken from the concrete being poured around the draft

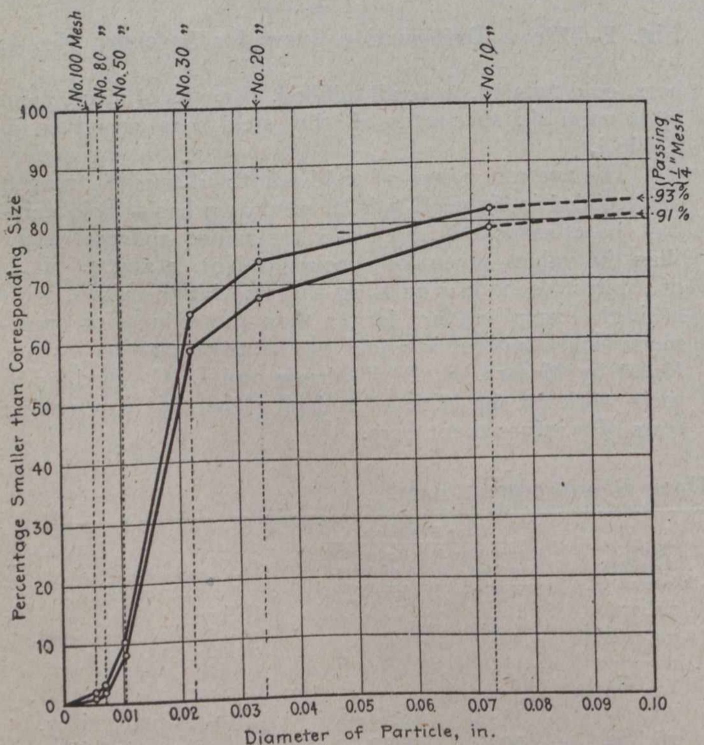

Fig. 2.—Granulometric Analysis Curve for the Sand.

tubes at the same time the test specimens were being prepared. It was not a laboratory-mixed batch, but was mixed and delivered under conditions similar to those encountered on the work.

The cement was Alpha Portland, meeting the requirements of the specifications of the society. A typical analysis is given in Table II.

The sand was very nearly a 1:1 mixture of Monongahela River and Cheat River crushed sand. It had a specific gravity of 2.54, a silt content of about 4.0 per cent., a void space of about 40 per cent., and weighed approximately 95 lbs. per cu. ft. The granulometric analysis curve is shown in Fig. 2.

The coarse aggregate used was Cheat River crushed gravel, having a specific gravity of 2.62, a void space of about 45 per cent., and weighed approximately 91 lbs. per

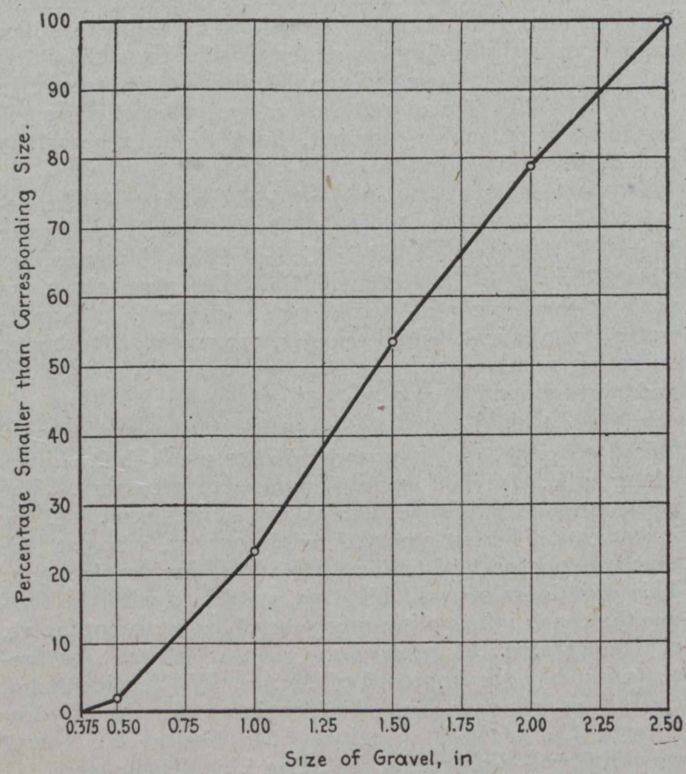

Fig. 3.—Mechanical Sieving Analysis Curve for the Coarse Aggregate.

cu. ft. The mechanical sieving analysis curve is shown in Fig. 3.

Some of the pieces of aggregate were taken from broken concrete test cylinders, and show the adhesion of mortar; other pieces were taken directly from the crusher.

Conclusions.—The conclusions which may be drawn from the tests are as follows:—

1. The 4-in. difference in lengths of lap tested, of one bar upon the other, apparently does not affect the rigidity or strengthen the splice.

2. The clamped lap splices not embedded in concrete sustain, on the average, a slightly greater load before first slip, and a larger maximum load than the clamped butt splices.

3. Splices consisting of two bars of opposite twist probably sustain a greater load before first slip, and a larger maximum load, than do splices in which the bars have like twist.

4. When U-bolt clamped lap splices (of the type, size, and lengths herein reported upon) are embedded in masses of concrete similar to those of the test specimens, the splices may be expected to withstand a stress before first slip equal to at least one-half the yield-point stress of the continuous reinforcement bar. Also, the maximum strength of such splices is probably equal to at least three-fourths of the tensile strength of the bar.

5. When U-bolt clamped lap splices (of the type and lengths herein reported upon) are embedded in relatively

large masses of concrete, it is reasonable to suppose that first slip would not occur, or the splice would not completely fail, before the yield point or tensile strength, respectively, of the reinforcement steel had been reached; for in such cases the splices would undoubtedly fail only by the pulling out of the bars along the grooves (either through untwisting or through direct shear), and not by splitting of the surrounding concrete. In either case, unlike the results in the tests, the clamps would remain embedded in the concrete, unless the concrete prism directly compressed by the area of the upper or lower clamps were pulled out also, a condition which is not in the least likely to occur with a relatively large mass of concrete.

6. Hence, for purposes of design, it is probable that such U-bolt clamped lap splices, embedded in concrete under conditions ordinarily obtaining in actual practice, could safely withstand a unit load equal to the allowable unit stress in the steel reinforcement bars.

LABORATORY TESTS FOR ROAD BUILDING MATERIALS.*

WITH the development of the science of highway construction has grown a demand for means whereby the qualities of materials used in the construction of roads may be determined quickly and accurately, as it is recognized that the success or failure of a road depends to a great extent on the properties of the materials used.

In 1914, the Ontario Department of Public Highways undertook the testing of stone, gravel, and sand, and since the commencement of this work much valuable information has been obtained with regard to the use of these materials in road construction. As the majority of the roads throughout the province are of macadam construction the greater part of the work has been confined to the testing of stone and gravel for use in this type of road; but attention has been given to these materials for use in concrete and bituminous pavements.

As early as 1878 highway engineers in France saw the advantages that were to be gained by the investigation of the road building qualities of rocks by means of laboratory tests, and a road materials laboratory was founded in the French School of Roads and Bridges. The Deval Abrasion Test for determining the wearing qualities of rock, which is used in all highway laboratories at the present time, was evolved. In 1893 the Massachusetts Highway Commission established a laboratory in the Lawrence Science School of Harvard University, this step marking the introduction of laboratory tests on highway materials on this continent. The use of the Deval test was supplemented by the use of a test for determining the binding power of rock powder.

Action of Traffic on Macadam.—The action of traffic on the surface of a waterbound macadam road takes place in several ways. The impact of the caulks on the horses' shoes tends to break not only the stone particles on the surface but also to dislodge them from their bed in the surface of the road; the grinding action of the steel tires and the rubbing together of the individual stones causes the surfaces of these to wear off in the form of powder; and the suction of the rubber tires of self-propelled vehicles throws the natural cement formed by the rock powder from between the surface particles and it is carried away in the form of dust.

In order to resist these destructive actions it is necessary that the stone be tough, that it resist abrasion, and that the rock powder has the property of forming a strong bond when sprinkled and rolled.

Toughness of Rock.—The toughness of the rock is determined by drilling a small cylinder from the sample and subjecting it to impact obtained by the fall of a hammer from known heights. The number of blows required to fracture the specimen represents the toughness of the rock. The ability of the rock to resist abrasion is obtained by revolving a known weight of the crushed stone in a cast-iron cylinder, for 10,000 revolutions, and determining the amount that is worn off in the form of powder. The amount lost is calculated in terms of the original weight as the per cent. loss and is expressed in this way, or by the coefficient of wear which is obtained by dividing 40 by the per cent. of wear. The binding power of the rock is found by grinding a small portion of the sample with water, moulding the resulting dough into cylinders and testing them by impact in a manner somewhat similar to that used for the test for toughness. Other determinations are made, such as specific gravity and weight per cubic foot, but these are for the purpose of general information only.

When the rock is to be used as an aggregate for concrete the same tests are made. The results of the cementing value test are not of any importance as this quality is not required in a rock for this class of work.

Gravel is subjected to the same tests as rock except that, owing to the nature of the material the toughness test cannot be made, and two tests for cementing value are made instead of one as in the case of rock, the first being on all material passing the 4-mesh screen and the second on the material passing the ½-inch and retained by the 4-mesh screen. The abrasion test is made on all material retained on the ½-inch screen. In addition to these tests, a sieve analysis is made on both the coarse and the fine materials with a view to determining the proportions of the different sizes of particles present.

Sand to be used as a fine aggregate for concrete is subjected to the sieve analysis and tensile and compressive tests on mortar specimens made from the sample. The amount of silt and clay present is also determined, as an excess of these materials will render the sand unfit for use.

Department Tests for Municipalities.—The department is prepared to conduct tests and furnish reports on samples of materials as required by municipalities. Upon application to the department instructions for taking samples together with tag envelopes will be forwarded.

Standard Bridge, Culvert, and Abutment Plans.—The Municipal Act requires that all county bridges, and township bridges with spans greater than 20 feet, be designed and built according to specifications approved by the Department of Public Highways. In some instances this requirement has not been met until construction has been commenced or completed, and it would be well for municipalities to communicate with the department prior to the undertaking of any construction work coming within the scope of the act.

The department has prepared general plans for steel bridges of Classes "A," "B" and "C." Plans for concrete abutments for these have also been prepared. The bridge plans cover designs for steel bridges of 16 and 18-foot roadways with spans of from 20 to 86 feet. Plans for concrete culverts have also been prepared covering all slab culverts of spans from 4 to 20 feet.

These plans will be published at an early date, but in the meantime, upon application to the department, municipalities and engineers will be furnished with blue prints of any of the standard plans which they may require.

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*Public Service Bulletin.

WOOD BLOCK PAVING SPECIFICATIONS.

THE following interesting report was made last month to the American Society of Municipal Improvements by the society's committee on wood block paving specifications:—

At the last meeting of the Society, in 1915, there was adopted a motion,—

"Directing the secretary to print in the proceedings, a request that members submit to the chairmen of the several sub-committees any matter which they wish to bring to the attention of the committee, at least ten days before the time of holding the convention."

In compliance with such request, P. C. Reilly submitted a specification; also W. H. Fulweiler, chemist of the United Gas Improvement Company; C. N. Forrest, chemist of the Barber Asphalt Paving Company, and J. W. Howard, consulting engineer. During the year no further specifications were submitted to the committee.

These specifications, together with the ones submitted to the society and printed as information, have been before the members for the past year, and no comments, pro or con, have been expressed, so that as far as the committee is concerned, we know of nothing further as to the opinions of the members of the society than we did a year ago, but the creosoting and use of wood blocks has been going on, notwithstanding the fact that no specifications have been adopted by the society.

There were some correspondence and conferences of the committee as to the advisability of a joint meeting of the creosoted wood block committees of the various societies dealing with such matters, but no agreement was arrived at—but we thought that such a meeting would be of great benefit.

At the request of the chairman of the committee on standard specifications, Geo. W. Tillson, such a meeting was called to be held in Brooklyn, N.Y., on September 12th, 1916.

There were present at this meeting, two members representing the American Society of Civil Engineers; four representing the American Society of Municipal Improvements; one representing the American Railway Engineering Association; one representing the Southern Pine Association; seven representing the American Wood Preservers' Association, and five representing the American Society for Testing Materials.

This was the most important meeting ever held affecting the creosoted wood block interests. All matters pertaining to the wood block industry were fully discussed at this meeting, and the most vital parts of the specifications as herewith submitted, *viz.*, the oil and treatment, were unanimously adopted by this general conference. The matter of the use of other oils than the ones submitted was gone over thoroughly, and it was the consensus of opinion that we were not ready to submit for adoption a specification permitting the use of water-gas tar wholly or in part, without more data and investigation of its qualities as a preservative. The members were, however, willing and ready to follow up and investigate all authoritative cases where water-gas tar had been used and see if the results were as claimed; but from all the information at hand we did not consider it wise to recommend a water-gas tar specification.

Especially to be emphasized is the fact that a strong committee of the American Wood Preservers' Association is now at work compiling data and a full report to be submitted to their association in January. This report will doubtless form the basis for a report to this society next year.

In regard to the specification for coal-tar oils herewith presented for adoption, it is almost the same as the one presented to the society at its last meeting in Dayton, Ohio.

The material points of difference are:—

1st.—The oil specification has been divided and a separate clause provided for a mixed coal-tar and creosote oil, called "coal-tar paving oil," and a straight distillate oil called "coal-tar distillate oil."

2nd.—The "treatment" clause has been more minutely defined and the different processes in the treatment limited so that a better block will be the result. Not only a better block, but one which will give better results in the pavement—and which will eliminate most of the troubles which are charged against the wood block pavement.

The amount of oil to be used has been limited to sixteen pounds per cubic foot; which is also along the right lines to reduce bleeding.

Following are the submitted specifications for creosoted wood block paving:—

TIMBER.

Kind.—The wood from which the blocks are to be manufactured shall be southern yellow pin, Douglas fir, tamarack, Norway pine, hemlock or black gum. Only one kind of wood shall be used in any one contract.

Quality.—The blocks must be sound and must be well manufactured, square butted, square edged, free from unsound, loose or hollow knots, knot-holes and other defects such as shakes, checks, etc., that would be detrimental to the blocks.

The number of annual rings in the one inch which begins two inches from the pith of the block shall not be less than six, measured radially; provided, however, that blocks containing between five and six rings in this inch shall be accepted if they contain 33⅓ per cent. or more summer wood. In case the block does not contain the pith, the one inch to be used shall begin one inch away from the ring which is nearest to the heart of the block. The blocks in each charge shall contain an average of at least 70 per cent. of heartwood. No one block shall be accepted that contains less than 50 per cent. of heartwood.

Size of Blocks.—The blocks shall be from five to ten inches long, but should preferably average two times the depth; they shall be * inches in depth. They may be from 3 to 4 inches in width, but in any one city block all of them shall be of uniform width. A variation of 1/16 inch shall be allowed in the depth, and ⅛ inch in the width of the blocks from that specified. In all cases the width shall be greater or less than the depth by at least ¼ inch.

PRESERVATIVE.

Kind.—The preservative to be used may be either a coal-tar paving oil or a coal-tar distillate oil, as herein specified; or where refined water-gas tar is desired, the specification as below suggested may be used.

Coal-tar Paving Oil.—The oil shall be a coal-tar product of which at least 65 per cent. shall be a distillate of coal-gas tar or coke oven tar, and the remainder shall be refined or filtered coal-gas tar or coke oven tar. It shall comply with the following requirements:—

1. It shall not contain more than 3% of water.

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*The committee recommends blocks 4 inches in depth for very heavy traffic streets; blocks 3½ inches in depth for moderate traffic streets. For light traffic streets blocks 3 inches in depth may be used, but where 3-inch blocks are used, no block shall be longer than 8 inches.

2. It shall not contain more than 3% of matter insoluble in benzol.

3. The specific gravity of the oil at 38° C. shall not be less than 1.07 nor more than 1.12.

4. The distillates, based on water-free oil, shall be within the following limits: Up to 210° C., not more than 5%; up to 235° C., not more than 25%. The residue above 355° C., if it exceeds 35%, shall have a float test of not more than 80 seconds at 70° C.

5. The specific gravity of the fraction between 235° and 315° C. shall not be less than 1.02 at 38°/15.5° C. The specific gravity of the fraction between 315° and 355° C. shall not be less than 1.09 at 38°/15.5° C.

6. The oil shall not yield more than 10% coke residue.

Coal-tar Distillate Oil.—The oil shall be a distillate of coal-gas tar or coke oven tar, and shall comply with the following requirements:—

1. It shall not contain more than 3% of water.

2. It shall not contain more than 0.5% of matter insoluble in benzol.

The specific gravity of the oil at 38° C. shall be not less than 1.06.

4. The distillates, based on water-free oil, shall be within the following limits: Up to 210° C., not more than 5%; up to 235° C., not more than 15%. The residue above 355° C., if it exceeds 10%, shall have a float test of not more than 50 seconds at 70° C.

5. The specific gravity of the fraction between 235° C. and 315° C. shall be not less than 1.02 at 38°/15.5° C. The specific gravity of the fraction between 315° C. and 355° C. shall be not less than 1.09 at 38°/15.5° C.

6. The oil shall yield not more than 2% of coke residue.

In view of the fact that some cities are using a water-gas tar, your committee deems it advisable to suggest a specification for their guidance. This specification is the one submitted and agreed to by C. N. Forrest, chemist of the Barber Asphalt Paving Company, and W. H. Fulweiler, chemist of the United Gas Improvement Company, as follows:—

The preservative shall be refined water-gas tar, and shall comply with the following requirements:—

1. The specific gravity shall be not less than 1.12 nor more than 1.14 at 38° C., referred to water at the same temperature.

2. Not more than 2.0% shall be insoluble by hot extraction with benzol and chloroform.

3. On distillation which shall be made as hereinafter described, the distillate, based on water-free oil, shall be within the following limits: Up to 210° C., not more than 5.0%; up to 235° C., not more than 15.0%; up to 315° C., not more than 40.0%; up to 355° C., not less than 25.0%.

4. The specific gravity of the total distillate below 355° C. shall not be less than 1.00 at 38° C., referred to water at the same temperature.

5. The oil shall not contain more than 2.0% water and due allowance shall be made for all water and insoluble foreign matter it may contain by injecting a corresponding additional quantity into the blocks.

Treatment.—The timber may be either air-seasoned or green, but should preferably be treated within three months from the time it is sawed. Green timber and seasoned timber shall not, however, be treated together in the same charge. The blocks shall be treated in an airtight cylinder with the preservative heretofore specified. In all cases, whether thoroughly air-seasoned or green, they shall first be subjected to live steam at a temperature between 220 and 240° F., for not less than two hours nor more than four hours, after which they shall be subjected to a vacuum of not less than 22 inches, held for at least one hour. While the vacuum is still on, the preservative oil, heated to a temperature of between 180° and 220° F. shall be run in until the cylinder is completely filled, care being taken that no air is admitted. Pressure shall then be gradually applied not to exceed 50 lbs. at the end of the first hour, nor a hundred pounds at the end of the second hour, and then maintained at not less than 100 lbs. nor more than 150 lbs. until the wood has absorbed the required amount of oil.*

After this, a supplemental vacuum shall be applied, in which the maximum intensity reached shall be at least 20 inches, and shall continue for a period of not less than 30 minutes. If desired, this vacuum may be either preceded or followed by a short steaming period.

In any charge the blocks shall contain at least 16 pounds of water-free oil per cubic foot of wood at the completion of the treatment. The blocks, after treatment, shall show satisfactory penetration of the preservative, and in all cases the preservative must be diffused throughout the sapwood. To determine this, at least 25 blocks shall be selected from various parts of each charge, and sawn in half at right angles to the fibres, through the centre, and if more than one of these blocks show untreated sapwood, the charge shall be re-treated. After re-treating, the charge shall again be subjected to a similar inspection.

The surface of the blocks after treatment shall be free from deposit of objectionable substances, and all blocks that have been materially warped, checked or otherwise injured in the process of treatment shall be rejected.

Handling Blocks After Treatment.—Blocks shall preferably be laid in the street as soon as possible after being treated. If they cannot be laid within two days, provision shall be made to prevent them from drying out by stacking in close piles and covering them, and if possible, sprinkling them thoroughly at intervals. The blocks shall be well sprinkled, under direction of the purchaser, about two days before being laid.

Inspection.—All material herein specified and processes used in the manufacture of the blocks therefor, shall be subject to inspection, acceptance or rejection at the plant of the manufacturer, which shall be equipped with all the necessary gauges, appliances and facilities to enable the inspector to satisfy himself that the requirements of the specifications are fulfilled.

The purchaser shall have the further right to inspect the blocks after delivery upon the street, for the purpose of rejecting any blocks that do not meet these specifications, except that the plant inspection shall be final with respect to the oil and treatment.

FOUNDATION.

The foundation for the pavement shall be of concrete made in accordance with the specifications for concrete paving foundations and shall be † inches in thickness

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*This treatment is recommended for yellow pine only. It is probably also suited to Norway Pine, Hemlock, Black Gum and Tamarack, but not to Douglas Fir. Further recommendations on the treatment of these species are reserved for the future.

†NOTE.—The committee recommends that the concrete base be at least 5 inches in thickness, and under heavy traffic 8 to 9 inches is recommended.

At no place shall the surface of the finished concrete vary more than ½ inch from the given grade.

CUSHION.

"*A*" *Bituminous*.—Over the concrete foundation laid as specified above shall be spread a layer of cement mortar composed of one part Portland cement to two parts of sand. This mortar shall be of such a consistency that it may be easily spread, and must be applied to the surface of the concrete not more than 45 minutes after the placing of the concrete foundation. This mortar must be struck by templates to a surface parallel to the grade and contour of the finished pavement in such a manner that when the blocks are set the surface of the pavement shall conform accurately to the established grade. After this mortar coating is thoroughly set and hardened, it shall be painted with a coal-tar pitch as specified under bituminous filler, or other suitable waterproofing paint. The paint coat must be applied as thinly and as smoothly as possible, and at no place shall it be over ⅛ inch in depth. The blocks shall be laid as specified below, directly on this paint coat, within at least 30 minutes after it has been applied.

"*B*" *Mortar Bed*.—The concrete foundation prepared as specified above shall be cleaned and swept, and shall be thoroughly dampened immediately in advance of the spreading of the cushion course. Upon the surface of the foundation thus prepared shall be spread a layer of mortar not exceeding ½ inch in thickness and made of one part Portland cement of the character specified for use in the foundation, and three parts of sand. Only sufficient water shall be added to this mixture to insure a proper setting of the cement, the intention being to produce a granular mixture which may be raked or struck by templates to the desired grade. The mortar shall be thoroughly mixed and shall be spread in place upon the foundation by means of templates immediately in advance of the laying of the blocks to such a thickness that when the blocks are set and properly bedded in the mortar, their tops shall conform accurately to the finished grade of the roadway.

"*C*" *Sand*.—Upon the concrete foundation shall be spread a cushion of sand 1 inch in thickness. The sand cushion shall be struck by templates to a surface parallel to the grade and contour of the finished pavement in such a manner that when the blocks are set and thoroughly bedded in the sand, the tops shall conform accurately to the finished grade of the pavement. The sand used in this cushion shall all pass through the ¼-inch screen and must contain between 10 and 25% of loam or clay.

LAYING THE BLOCKS.

Upon the bed thus prepared the blocks shall be carefully set, with the fibre of the wood vertical, in straight, parallel courses, leaving a space next to the curb one-inch in width for the expansion joint.

They shall be placed closely together on the prepared cushion, and no joint shall be more than ⅛-inch in width. Nothing but whole blocks shall be used except in starting a course, or in such other cases as the purchaser may direct; and in no case shall the lap joint be less than two inches. Closures shall be carefully cut and trimmed by experienced men. The portions of the block used for the closures must be free from checks or other fractures, and the cut end must have a surface perpendicular to the top of the block and cut to the proper angle so as to give a close, tight joint. The angle of the course with the curb shall be determined by the purchaser.

After the blocks are placed they shall be rolled parallel and diagonal to the curb by a tandem roller, weighing between four and seven tons, until the surface becomes smooth and is brought truly to the grade and contour of the finished pavement. In case of a mortar bed, the rolling shall be completed before the mortar bed has set. All mortar that has set before the blocks are in place and rolled shall be discarded and replaced by fresh mortar.

FILLER.

"*A*" *Bituminous*.—After the rolling is completed, the joints between the blocks shall be filled with either a pitch or asphalt filler as specified hereafter. The filler shall be brought to the proper temperature and shall be poured into the joints, and any filler on the surface of the pavement must be spread as thinly as possible by means of squeegees. The receptacle in which the filler is heated shall be equipped with suitable thermometers.

After the joints are filled as prescribed, the surface shall be completely covered by a thin coat of clean, coarse, dry sand, and a similar coating of sand shall be spread over the pavement, if required by the engineer, before the acceptance of the pavement.

"*A*" *Pitch Filler*.—The filler shall be a straight run residue obtained from the distillation of coal tar, and shall comply with the following requirements:—

1. The melting point shall be not lower than 140° F. nor higher than 150° F.

2. It shall contain between 22 per cent. and 37 per cent. of free carbon insoluble in hot chloroform and benzol.

3. Its specific gravity at 77° F. shall not be less than 1.24 nor more than 1.32.

4. The specific gravity of the distillate up to 355° C. shall not be less than 1.07 at 38° C. compared with water at 15.5° C.

The pitch shall not be heated to a temperature exceeding 325° F., and shall be poured at a temperature between 250° F. and 300° F.

"*B*" *Asphalt Filler*.—The filler shall be an asphalt cement, and shall comply with the following requirements:—

1. It shall contain at least 98 per cent. of bitumen soluble in carbon di-sulphide.

2. It shall have a penetration within the following limits:—

When tested at 32° F. for 1 minute under 200 grams, 10 to 20.

When tested at 77° F. for 5 seconds under 100 grams, 30 to 50.

When tested at 115° F. for 5 seconds under 50 grams, 150 to 300.

3. It shall show a ductility of at least 30 centimeters when tested at 77° F.

4. When 50 grams are heated in an open tin to a temperature of 325° F. for 5 hours, the loss shall not exceed 1 per cent., and the penetration at 77° F. of the residue left after such heating must not be less than two-thirds (⅔) of the penetration of the original asphalt cement before such heating when tested at 77° F.

"*B*" *Sand*.*—After the rolling is completed, the joints between the blocks shall be filled by sweeping dry,

(Continued on page 387.)

*Sand filler and sand cushion have caused many failures, and where used, special care should be exercised.

WATER SUPPLY OF THE CITY OF PORT ARTHUR.*

By L. M. Jones, A.M.Can.Soc.C.E., City Engineer.

THE report regarding the water supply and the establishing of an intake and pumping station at the location decided upon was submitted to the council of Port Arthur on November 30th, 1911, and was adopted in general. On account of the largeness of the undertaking and the abandonment of the old plant, it was considered advisable to submit the whole matter to a consulting engineer for opinion and report. For this purpose Mr. T. Aird Murray, M.Can.Soc.C.E., was called in and after full consideration of the question, he recommended to the council that the report of the city engineer be adopted.

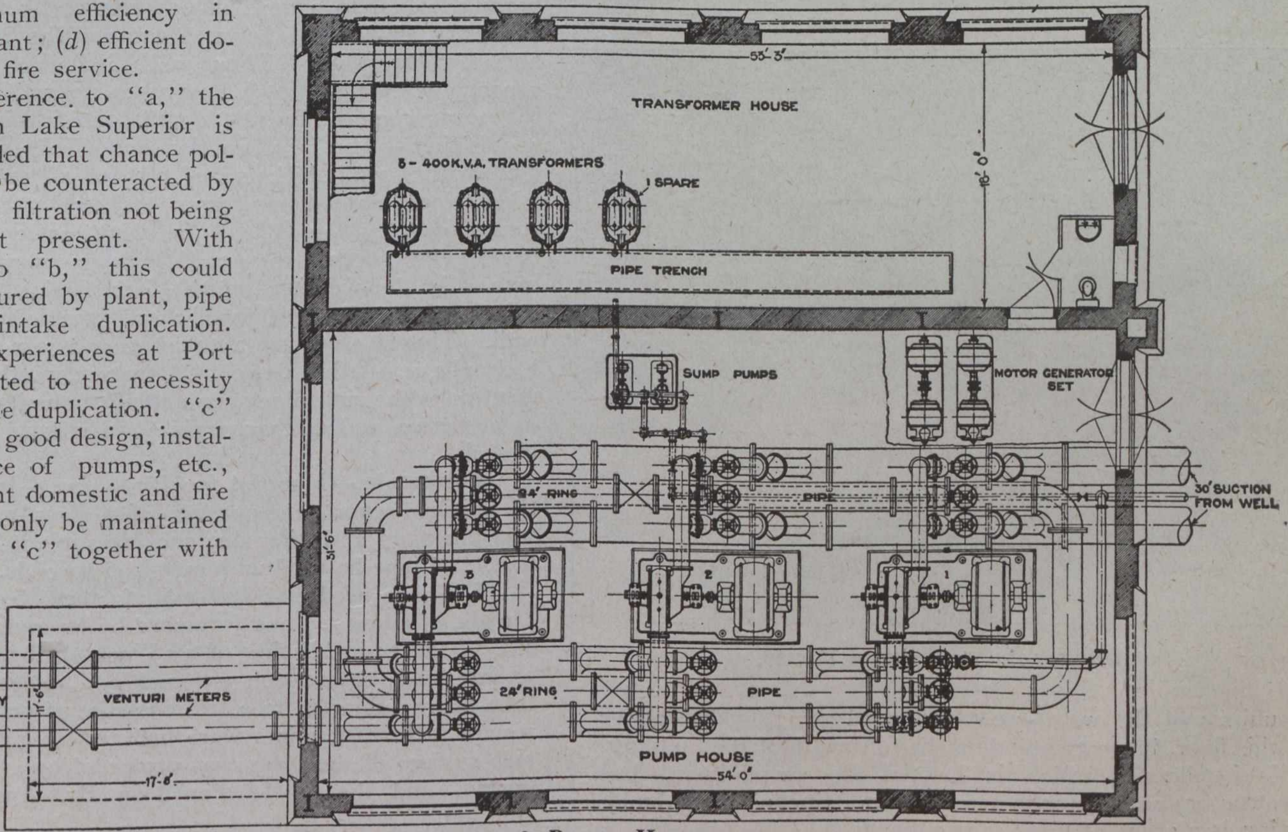
Description of New Water Supply System.—General.—In the preliminary investigations the aim was to acquire the following as far as possible: (*a*) A pure supply of water; (*b*) a continuous service; (*c*) maximum efficiency in pumping plant; (*d*) efficient domestic and fire service.

With reference to "a," the supply from Lake Superior is good provided that chance pollution may be counteracted by disinfection, filtration not being required at present. With reference to "b," this could best be secured by plant, pipe line and intake duplication. Previous experiences at Port Arthur pointed to the necessity of reasonable duplication. "c" is subject to good design, installation, choice of pumps, etc., while efficient domestic and fire service can only be maintained by "b" and "c" together with watchfulness, foresight and courtesy exercised by employees in operation. Efficiency in the mechanical and technical design is of little avail if the human factor is not efficient. The policy of anyone having a product or commodity for sale should be to satisfy, and this should not be forgotten by those managing or operating waterworks.

All the material except pumping equipment was furnished by the city at the site of the works, the pipes and fittings being purchased from Drummond, McCall & Co., and the valves from the Rensselaer Valve Co.

Intake Pipes.—General Description.—The intake consists of duplicate pipes 24 inches in diameter extending from the well the pipes pass through a rock tunnel, the the minimum depth of the top of pipes being 28 feet from low-water level, thus allowing for dredging a harbor of 25-foot draught. At the outer end is a rock-filled crib supported on piles, through which the pipes pass vertically for a distance of 14 feet, and on this crib and over the inlets are placed screens of ¾-inch copper mesh. To take care of any possible settlement, flexible joints were placed at the base of the crib and sufficient clearance allowed for this between pipes and screen collars. Valves were placed near the flexibles for closing off supply. The depth of water at the crib is 47 feet. For a distance of 510.5 feet from the well for a distance of 2,350 feet into the lake, remainder of the pipe lines being supported on piles, with flexible joints at changes of grades.

Pipe Line Material.—The pipe used was manufactured by Stewarts & Lloyds and the American Spiral Pipe Co., the former being of ¼-inch shell thickness with loose cast steel flanges, bolted together with twenty 1¼-inch bolts, with rubber gaskets at joints, and were wrapped with burlap. The latter was about 3/16-inch shell thickness, with plain flanges rivetted to the pipes, and drilled



Plan of Pump House.

to receive sixteen ⅝-inch bolts, gaskets being similar to the former. These pipes were coated with asphaltum.

Tunnel.—Work was commenced on the tunnel on October 1st, 1913, and completed February 19th, 1914.

The character of the rock encountered was fine grain basalt, with numerous pockets or deposits of black or gray flint, which made drilling extremely slow. The mucking was done by ordinary methods of tracks and cars, the car being hoisted to the surface by derricks. There were 996 cubic yards of rock removed, entailing 11,304 lineal feet of drilling and about 7,000 lbs. of 70% gelignite. There were 209 working shifts, the average advance per shift being 2.44 feet. The length of the air lock was 38 feet between bulkheads.

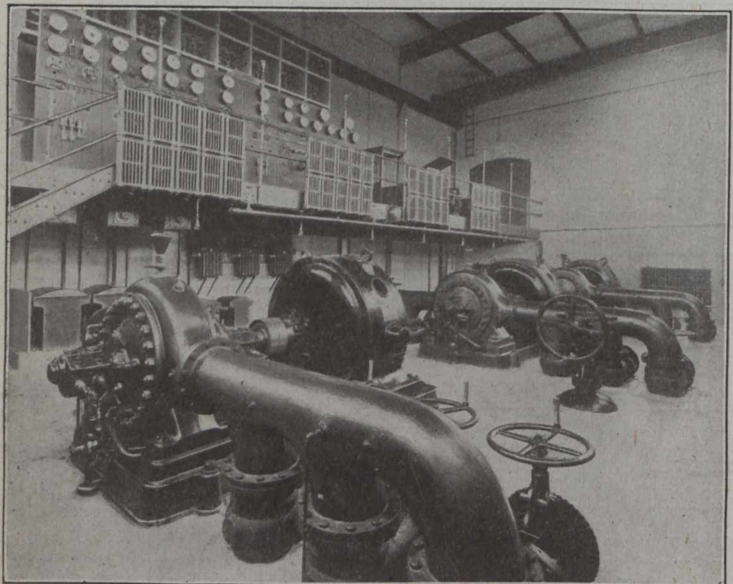
Pumphouse and Pumping Equipment.—At the present time Port Arthur is supplied with electrical power from two separate and distinct sources—*viz.*, Current River,

*Abstract of paper read before the Canadian Society of Civil Engineers, November 2, 1916.

owned and operated by the city, and Kakabeka Falls, the city having this power for sale also, by arrangement with the Hydro-Electric Power Commission of Ontario, and by agreement with the commission.

The old pumping system was operated against the full head of the stand-pipe and as investigations revealed that 75 per cent. of the water pumped was used below a contour line drawn about midway between the lake level and the top of the stand-pipe and the balance above that line, it was decided to put in a "booster" pump to serve the upper levels and also to provide adequate fire pressure. All the new pumps are motor-driven centrifugals.

Pumphouse.—The building is a fire-proof structure 31½ x 54 feet inside dimensions, sufficient to house the present equipment, future additions to the plant requiring extensions to the building. On top of the concrete roof slab, a false timber roof was constructed, covered with felt and gravel, to prevent sweating and dripping. There are practically three floor levels. On the lower floor are the large pipes, sump pumps, heating plant and coal bin. The next is the main floor, having the three pumping units and the water-recording apparatus; whilst above this floor, but not extending the full width of the building, is a gallery on which is located the switch-board, bus structure and motor generator sets. Spanning the building is a crane of eight tons capacity.



Interior View of Pump House.

In order to secure the most efficient suction lift, when in the future the full head of the intake pipes was being utilized, it was decided to set the centre line of the pumps at lake level. This meant deep excavations, water-tight walls and first-class piping equipment.

In the walls of the basement "Ceresit" waterproofing compound was used in proportions of one-half pound to one cubic foot of concrete, the concrete being one part Portland cement to four parts lake shore gravel. When the water was allowed to rise to normal or lake level, there were slight signs of leakage in a few places, but gradually these have taken up until now all these signs have disappeared.

Pumps.—All the foundations, pipe supports, crane, etc., were supplied by the city, the contractor being required to supply and erect on the foundations all the pumping equipment complete with piping and electrical apparatus. The contract was awarded to Messrs. Escher, Wyss & Co. (Canadian branch), for their type of pump and electric motors and equipment manufactured by Siemens Brothers. The "booster" pump was supplied by Chapman and Walker, of Toronto, it being manufactured by W. H. Allen & Sons, Bedford, England.

The three main pumping units are centrifugal, two-stage, single-suction pumps, having a 12-inch suction branch and a 12-inch delivery branch, the horizontal lines of these branches being at the same elevation. They are designed for 2,000 Imperial gallons per minute when pumping against a head of 300 feet, the speed being 1,200 r.p.m., and a guaranteed efficiency of 76 per cent. with a 2 per cent. margin. The impellers, guide apparatus and all parts coming in contact with the water are special bronze, a nickel steel shaft covered with bronze, self-lubricating bearings of the ring type and a patent balancing device for eliminating axial thrust. There is no necessity to disconnect piping to gain access to the internal parts. The pumps will operate in parallel or in series, as may be desired, and when working in series will deliver the capacity of one pump at twice the head, or a pressure equal to a head of 600 feet can be obtained if necessary, or a range between 300 and 600 feet is available by throttling. They will discharge their rated capacity with a suction lift between 19 and 20 feet and the power required for the stated condition is 244 b.h.p.

Piping.—The large suction and discharge pipes are steel with a wall thickness of 7/16 of an inch, while all other pipes, specials and branches, are cast iron. The connections are flanged and the valves are equipped with bevel gears so that they can be easily operated by one man. At the well end of the force mains 6-inch relief valves are installed with a discharge pipe returned to the wall. These valves are automatic and are fitted with hydraulic regulating device. A feature worthy of special mention is the ring pipe surrounding the units. This acts as a suction and discharge pipe and is used in pumping in series.

Forcemain.—Material for Pipe Line.—In preparing the original reports the question of steel vs. cast-iron pipe was taken up and after due consideration it was decided that steel pipe be used with cast-iron specials.

The pipe used was that manufactured by Stewarts & Lloyds, of Glasgow, and furnished by Drummond, McCall & Co., the 24-inch being of 5/16-inch shell thickness and 25 feet long, the 12-inch 3/16-inch and 20 feet long, each tube being subjected to a test pressure of 500 pounds per square inch. All joints were bell and spigot. The outside surface of the pipes was protected by a wrapping of burlap, and the whole dipped in Dr. Angus Smith's solution.

Castings.—The special castings for junctions at street intersections, etc., were of standard design, some having flanged ends and some bell and spigot, all being subject to the same test pressure and furnished by the same company.

Valves.—The valves were those manufactured by the Rensselaer Valve Co., of Troy, N.Y., constructed to their standards and tested to a pressure of 500 pounds per square inch. The 24-inch valves were equipped with gears, and some with by-passes.

Excavation.—The material encountered in the excavations varied greatly, there being loam, sand, gravel, hard-pan, muskeg and solid rock. For this reason bids were asked for in the form of unit prices, except on Section 8, as the material here was well known, the above material being classified as earth, rock and boulders. The ordinary methods of working were followed.

Pipe Laying.—The pipe laying was paid for at a unit price per foot, which included all pipe, specials, valves, fittings, etc., the material being placed alongside the trench by the city. The price also included all pipe cuttings, a cutter of special design being purchased by the city. A good deal of trouble was experienced in repairing the pipe wrapping and the dents in the ends of the pipes caused by rough handling in transit. Some of these were so battered and distorted that from two to twelve inches had to be cut off a large number of pipes, the cost being charged back to the company supplying. Greater care in handling steel pipe during shipment should be exercised, in order to receive the full benefit of their use.

CITY OF PORT ARTHUR.
DETAILS OF COST, NEW WATER SUPPLY SYSTEM.

UNIT PRICES FOR FORCE MAIN WORK.

Section Numbers.	1	2	3	4	5	6	7	8	9	10	Remarks.
Stumping per Lin. Foot.	0.06	0.05½	0.09	0.16	0.02	0.15	0.12	Lump Sum Price for All Work.	0.5½	0.5½	40 Feet Wide if Required.
Grading Earth per C.Y.	1.00	0.50	0.50	0.45	0.33	0.30	0.30		0.50	0.50	
Earth Overhaul per C.Y. per 100 ft.	0.03	0.10	0.10	0.02	0.03	0.02	0.02		0.10	0.10	
Earth Trenching per C.Y.	1.50	1.07	1.07	0.65	0.85	0.65	0.65		1.10	1.10	
Boulder Excavation per C.Y.	1.50	0.75	0.75	1.50	2.00	1.50	1.50		0.75	0.75	
Rock " " C.Y.	7.00	4.20	4.20	6.00	5.75	6.00	6.00		4.20	4.20	
Laying 24 in. Pipe per Foot.	0.60	0.19½	0.19½	0.10	0.20	0.10	0.10		0.19½	0.19½	
" 12 " " " "									0.15	0.15	
Borrow Fill per C.Y.	1.00	0.60	0.60	0.35	0.80	0.35	0.35		0.60	0.60	
Mass Concrete per C.Y.	16.00	9.05	9.03	8.00	8.50	8.00	8.00		9.03	9.03	
Reinforced " " C.Y.	25.00	10.12	10.12	8.25	8.50	8.25	8.25		10.12	10.12	

PUMP HOUSE.			
Earth Excavation per C.Y.	1	50	
Rock " " "	7	00	
Constructing Building, Excluding Excavation			20066.41
INTAKE WELL.			
Earth Excavation per C.Y.	1	50	
Rock " " "	7	00	
Cost of Constructing Well, Excluding Excavation.			5409.40
INTAKE.			
Laying Intake Pipe Including Tunnel Dredging & Pile Supports, But not Including Pipes & Valves			136321.89
TRANSFORMER STATION.			
Cost of Building Including Excavation.			12551.60
COST OF MATERIAL.			
Price per Foot for 24 In. by 5/16 In. Steel Pipe Standard Joint F.O.B. Port Arthur.			3.92½
" " " " 24 " " 5/16 " " " Long Sleeve Joint " " " " "			4.15
" " " " 24 " " 5/16 " " " Flanged Joint " " " " "			5.07
" " " " 12 " " 3/16 " " " Standard Joint " " " " "			1.45
" " 100 Lbs. " Specials in Cast Iron. " " " " "			5.20
" Each for 24 In. Flanged High Pressure Flexibles. " " " " "			360.00
" " " 24 " " Low " " " " " " "			251.00
" " " 24 " Gate Valves Bell Ends, Geared & By-Pass. High Pressure F.O.B. Port Arthur.			280.68
" " " 24 " " " Flanged " " " " " " " " " " "			290.43
" " " 24 " " " " " " No By-Pass " " " " " "			278.61
" " " 24 " " " " " " " " " Low " " " " "			187.31
" " " 12 " " " Bell Ends High Pressure " " " " "			49.10
" " " 3 " Klopp Automatic Air Valves. " " " " "			45.00
" " " 4 " Air Check Valves Manufactured by Crane Co. Chicago Ill.			9.50
" of Well Equipment.			4508.43
" " Transformers & Apparatus for Transformer Station			6531.57
" " Chlorinator. F.O.B. Port Arthur.			2339.68
SUMMARY OF TOTAL COSTS.			
Intake Complete to Well.			158639.33
Well "			12330.51
Chlorinating Plant Complete.			2501.75
Pump House Complete without Equipment.			28739.41
Pump House Equipment Including Pipes & Apparatus.			39828.16
Spur Track to Pump House.			1467.63
Two Operators Houses.			8948.43
Force Main Section No. 1 (Land Portion)			30184.90
" " " " 2			59075.33
" " " " 3			53375.77
" " " " 4			27841.59
" " " " 5			30324.46
" " " " 6			24942.24
" " " " 7			23632.48
" " " " 8			69250.58
" " " " 9			10502.71
" " " " 10			14916.15
TOTAL			$596501.43

Railway Crossings.—On Sections 1 and 2 the main lines of the C.N.R. and the C.P.R. had to be crossed, both being difficult crossings on account of solid rock excavation. All the temporary bridging was done by the railway companies, and the Standard Rules of the Board of Railway Commissioners was followed. For the entire width of the right-of-way extra heavy cast-iron pipe was used, the connections between steel and iron pipe being made with a special collar. This work was paid for at cost plus 15 per cent.

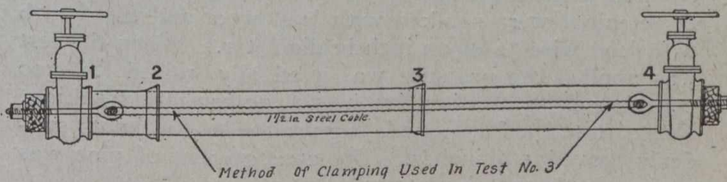
Current River Crossing.—In constructing the work on Section 8, besides the ordinary trenching and pipe-laying, the contractor was required to lay the pipe across Current River. About half a mile down stream from the crossing a permanent dam has been constructed in connection with the power development owned by the city, the portion of the river crossed forming part of the reservoir. The depth of water here is 14 feet in the river bed and about 5 feet near the shores, the length of the crossing being 450 feet.

Material.—The pipes were steel, similar to those used on the other parts of the force main, with the exception that the joints were the "long sleeve" type. This is a bell and spigot joint, but the spigot is inserted into the bell for a greater distance than is allowable for the standard joints and in putting the pipes together, by the time the spigot is in place, a driving fit is obtained. The caulking is similar to the other joint except that lead wool was used in place of run lead.

This type of joint is admirably suited to this purpose, its merit being that on account of the long inserted spigot there is less movement and a reduction in possibility of leakage.

The inclined pipes coming up to the shores were 30 feet long, connected to the horizontal pipes with flanged joints, as this connection had to be made under water. At the low point of the crossing a 6-inch valve was placed on each line for blow-off purposes.

Test of Pipe Joints.—Before pipe laying was commenced a series of tests of lead-caulked joints was carried out, and for this purpose some lengths of 12-inch pipe were used with a valve at each end of the line. The pipes were on blocking and standing free, and in all there were four joints. A small hand-pump was rigged up, having a displacement of three cubic inches per stroke.



Results of tests may be interesting and are shown in the accompanying tables.

Tests Performed on 3/16-in. x 12-in. Steel Bell and Spigot Pipe.

TEST NO. 1.

Pressure	Joint No. 1 Run Lead	Joint No. 2 Lead Wool	Joint No. 3 Run Lead	Joint No. 4 Lead Wool
110 lbs.	Sweating slightly	Sound	Sound	Sound
125 lbs.	Sweating freely	Sound	Sound	Sweating slightly
150 lbs.	Dripping freely	Sound	Sound	Sweating freely
200 lbs.	Dripping freely	Sound	Sound	Valve started to move off, leaking freely
225 lbs.	Dripping freely	Sound	Sound	Valve moved off 2½ in., leaking freely

In the above test the protective solution was left on spigot and bell.

TEST NO. 2.

Pressure	Joint No. 1 Run Lead	Joint No. 2 Lead Wool	Joint No. 3 Run Lead	Joint No. 4 Run Lead
110 lbs.	Sweating slightly	Sound	Sound	Sound
150 lbs.	Sweating	Sound	Sound	Sweating slightly
200 lbs.	Sweating freely	Sound	Sound	Valve jumped 1 in., and leaking freely

The spigot at joint was cut off and solution left on.

TEST NO. 3.

Pressure	Joint No. 1 Run Lead	Joint No. 2 Lead Wool	Joint No. 3. Run Lead	Joint No. 4 Lead Wool
200 lbs.	Sound	Sound	Sound	Sweating slightly
300 lbs.	Sweating slightly	Sound	Sound	Dripping
350 lbs.	Sweating freely	Sound	Sound	Running
400 lbs.	Moved ¼ in.	Moved ⅛ in., not leaking	Moved ¼ in., dripping	Running freely
450 lbs.	Lead started to blow	Sweating slightly	Moved 1 in.	Running freely but had not moved

Pipes were clamped in this test only, as shown on sketch. At 450 lbs. the pipe buckled at joint No. 3.

TEST No. 4.

Pressure	Joint No. 1 Run Lead	Joint No. 2 Run Lead	Joint No. 3 Run Lead	Joint No. 4 Run Lead
200 lbs.	Sound	Sound	Sound	Sweating
275 lbs.	Sound	Sweating freely	Sound	Sweating
290 lbs.	Sound	Jumped ¼ in., dripping	Sound	Sweating
300 lbs.	Sweating slightly	Dripping freely	Jumped ½ in., leaked badly	Dripping freely
340 lbs.	Sweating slightly	Dripping freely	Leaking badly and moving	Dripping freely
390 lbs.	Sweating slightly	Dripping freely	Moved 1 in., lead started to blow	Dripping freely

The spigot ends of all pipes were well scraped and brightened.

TEST No. 5.

Pressure	Joint No. 1 Run Lead	Joint No. 2 Run Lead	Joint No. 3 Run Lead	Joint No. 4 Run Lead
150 lbs.	Sweating slightly	Sound	Sound	Sound
200 lbs.	Sweating slightly	Sound	Sound	Sound
225 lbs.	Sweating freely	Sound	Sound	Sound
250 lbs.	Sweating freely	Sound	Sound	Sound
275 lbs.	Sweating freely	Sound	Sweating slightly	Sound
290 lbs.	Sweating	Sound	Jumped 1/16 in.	Sound
340 lbs.	Sweating	Sound	Moved ¾ in., lead started to blow at bottom	Sound

In this test 1¾ inches to 2¼ inches of lead were used in each joint instead of from 2½ inches to 3¼ inches during the previous tests.

The foregoing tests were made within a few hours of making the joints, and in order to ascertain what advantage there would be in leaving the joints for several weeks, a test was conducted four weeks later on pipes caulked when the above tests were made. In this test three joints were caulked with lead wool and the fourth with lead wire ⅜ of an inch in diameter. When the test was applied the pressure was gradually raised to 500 pounds per square inch with no perceptible sweating. When raised a few pounds higher one of the joints suddenly moved 1½ inches. The arrangement of pipe was similar to the previous tests.

One test was also applied on the 24-inch pipe as above, there being four joints in all, caulked with run lead, lead wool and lead wire. When the pressure reached 120 lbs., the run lead joints gave out. On account of cold weather no further tests were made.

It should be noted that the pressure exerted on the 12-inch gate at 500 lbs. per square inch, was 56,550 lbs., and on the 24-inch, 54,286 lbs. and 120 lbs. pressure.

Some points brought out in the tests are:—

1. It is evident that lead wool makes a better joint than run lead and lead wire better than lead wool.

2. That a depth of lead from 1¾ inches to 2 inches from the face of the bell is cheaper and just as efficient as a greater depth. Caulking had no effect on the lead beyond this depth.

3. The clean spigot allows of a better joint being made than one having a covering of solution.

4. That the run lead joints gave better results when pressure was applied about four weeks after making, than immediately after being made.

5. That none of the lead blew from the joints until considerable movement had taken place in the joint.

6. That better results would have been obtained had the pipe been laid in the trench and properly covered, for the reason that no movement would have taken place in the pipes if bends were anchored.

7. It is evident that all bends of considerable angle should be anchored to prevent movement. This was very clear with regard to the 24-inch pipe.

Arrangement of Valves.—The arrangement of the valves is such that should any section of the pipes between valve chambers be out of service for any reason, the section can be completely cut off and the supply continued through the other pipe.

FALLS AND RAPIDS ON THE ST. MAURICE RIVER.

The following table of heights of the various falls and rapids on the St. Maurice River, Quebec, is taken from the fourth report of the Quebec Streams Commission:—

Height of the Various Falls and Rapids on the St. Maurice River.

Name	Distance from Three Rivers.	Downstream elevation.	Upstream elevation.	Height.
Les Forges	8.2	11.5	22.4	10.9
Les Trois-Roches	9.6	24.6	27.3	2.7
La Gabelle	14.	39.5	49.8	10.3
Les Grès	15.3	50.2	94.8	44.6
Shawinigan	21	95.5	243.8	148.3
Les Hêtres	25.6	243.8	251.	7.2
Grand'Mère	30.6	251.	300.1	49.1
Grandes-Piles	36.5	302.9	311.7	8.8
Manigonce	54.8	331.8	335.2	3.4
Croche	90.2	362.1	364.4	2.3
La Tuque	104.5	384.2	475.2	91.
Martin	111.4	499.9	509.2	9.3
Petites Pointes	113.9	520.9	533.5	12.6
Grandes Pointes	115.2	535.1	554.6	19.5
Pointes à Gouin	116.8	563.7	568.9	5.2
Orignal	118.	575.3	582.	6.7
Stronique	121.8	607.3	616.8	9.5
Blanc	130-138.1	638.8	850.2	211.4
Les Cœurs	164.3	864.6	954.	89.4
Lièvre	177.9	977.9	996.5	18.6
Graisse	179.2	999.8	1035.4	35.6
L'Ilet	180.	1037.	1045.3	8.3
Iroquois	180.7	1046.1	1056.3	10.2
Petit-Rocher	182.1	1060.6	1070.2	9.6
De l'Ile	183.	1070.2	1118.8	48.6
Cache	185.4	1119.	1123.	4.
Weymontachingue	186.8	1123.7	1135.	11.3
Nine Mile	197.6	1138.5	1142.1	3.6
Chaudière	218.	1150.4	1183.3	32.9
Windigo	223.	1184.6	1190.2	5.6
Petit-Rocher	224.6	1190.3	1197.7	7.4
La Montagne	228.1	1197.8	1230.6	32.8
Bouleau	229.0	1230.9	1237.7	6.8
Cyprès	230.	1238.3	1252.4	14.1
La Loutre	233.9	1253.3	1277.6	24.3
Dam Site	237.	Water surface	1277.7	

The best-known hydraulic mine in California, and the largest now operating in the world, is La Grange mine in Trinity county. The operating company now has a water system of 29 miles of main ditch, flume, tunnel, and siphon, 7 miles of 30-in. water-pipe line, and 14 miles of auxiliary ditch not now in use. This is supplied with all necessary reservoirs and connections for bringing the water to the face of the pit, and with the dam at the lower lake represents an outlay of approximately $700,000.

American interests associated with the Union Carbide Company, of New York, have organized under the laws of Canada the Electric Furnace Products Company, Limited, and are building a large plant at Saude, Norway, for the manufacture of calcium carbide and other electro chemical products for sale in the American market. Edgar F. Price, an officer of the Union Carbide Company, is president of the new concern, which expects to have its plant completed for the beginning of shipments by 1918.

ECONOMICS AND COSTS OF MOTOR TRUCK OPERATION.*

By W. Howard Clapp.

MANY things contribute to make southern California an ideal field for the motor truck: perfect operating conditions throughout the year, many miles of good roads, city streets out into the country, a population which has scattered out instead of congesting, cheaper fuel than can be had in any other truck country, and a labor market where intelligent, careful drivers may be had for a moderate wage. For many kinds of haulage, covering a wide range of operation, the motor truck is distinctly superior to any other method of transportation. Given an active service at full load, with a terminal not definitely fixed and a radius of operation up to 30 miles, it is an exceptional condition which will justify any other method of goods haulage.

Some of the especially active fields for the truck in southern California are goods hauling to and from Los Angeles harbor, interurban delivery service, road building and wholesalers' delivery. There are, however, special considerations which may have considerable bearing upon the employment of a truck. A committee of the Boston Chamber of Commerce, in a detailed report on street traffic in Boston, covering eighteen months of study, reported that "development of motor trucks will tend to relieve congestion by moving all merchandise in larger units and more rapidly," and that "the average speed of motor vehicles in getting into and away from railway terminals is from two to three times that of the horse." This is especially applicable to Los Angeles, which has nearly two miles of as congested streets as are to be found in nearly any city.

Another great advantage of the motor truck to the retailer is that he not only can supply his customers more quickly, but also because of the greater mileage range his territory is increased to about eight times what he could serve with a horse.

Costs of Gasoline Trucks.—Fig. 1 gives curves of cost, weight and horse-power (average values) for all classes of gasoline trucks as listed by publishers of motor truck publications. The noticeable feature of these curves is the sudden break of each for the lighter trucks of less than 1 ton capacity. These show that the demand for a light truck has been met by making a vehicle which is much lighter for the rated load than the heavier trucks. This is possible because of the higher engine speed, a more simple final drive, torque and thrust taken through the vehicle springs, and by the generous use of special alloys and heat-treated steels. The curves suggest that these trucks are too light for the load that they are rated to carry. That this is true is abundantly proved by the records of many light trucks, which show that the average life of a light delivery truck is about 35,000 miles, whereas the heavier trucks, when properly driven and cared for, can be depended upon to give 80,000 to 100,000 miles, or even more for the better grade of trucks, if they are carefully driven and ordinary maintenance is kept up. It would seem that there is a real field for a more serviceable light truck which will at a little greater cost give enough lower depreciation and maintenance to be a profitable investment.

That there is a real field for such a truck not only for city service but also for use throughout the country is shown by the report of the U.S. government, which states that only 15 per cent. of the entire traffic of the country is moved by railroads and steamships combined, the remainder of 85 per cent. being carried for the most part in wagons, and the greater part of it in lots of 1,000 lbs. or less. This field has only been touched by the motor truck as yet, and to fully occupy it would require not less than two million light trucks. This estimate makes no provision for hauling done on the farm.

Table I. is an itemized cost statement for various sizes of gasoline trucks under average service conditions on the roads of southern California. These costs are conservative. It is possible to find plenty of examples of lower costs and also of costs that are much higher, but these costs are easily realizable for ordinary truck work in this locality. With proper management an even lower cost per day should be realized. That these costs are somewhat lower than averages for other localities may be largely credited to good roads and an equable climate. In making this table three conditions of operation are assumed: the costs for each size of truck are computed for a daily run of 25, 50 and 75 miles, and for each condition the life of the truck is estimated, and depreciation is based on this life. Costs are given in dollars for the entire life of the truck. First costs are average chassis costs in Los Angeles.

In California, distillate is being used to quite an extent as a substitute for gasoline. The cost per gallon is

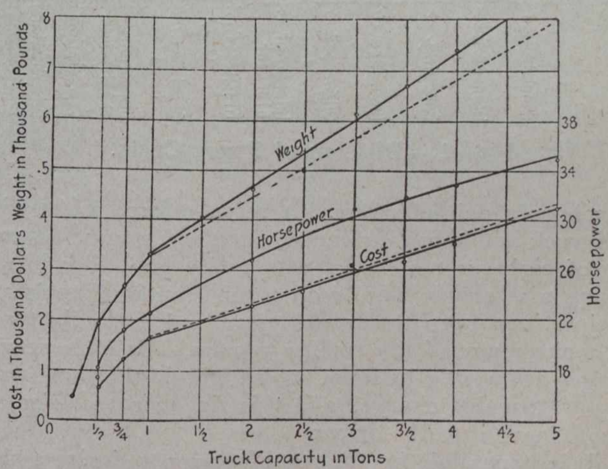


Fig. 1.—Averages from All Classes of Gasoline Motor Trucks.

about half that of gasoline at the present time, and the B.t.u. content somewhat greater. A local truck manufacturer has been very successful in equipping trucks with gasifiers by which the heat of the exhaust gases from the engine is used to heat the inlet air as it goes to the carburetor, and also to heat the mixture as it goes from the carburetor to the cylinder. A supply of gasoline is carried and used in starting. The consumption of distillate is about the same as that of gasoline. The success which has attended this innovation would seem to justify the claims of the manufacturer that the use of distillate does not increase carbon trouble. The question of a lessened volumetric efficiency is a negligible consideration.

Tires will outwear the manufacturers' guarantee at least 25 per cent. when used on the good roads of southern California. Smooth roads, dry surfaces and an equable climate all contribute to this result. Overloading and overspeeding are the things that shorten tire life. However, the important consideration is not tire economy, but economy of truck operation per ton of material carried; therefore, durability is only one factor that must be taken into account. Resilience, which prevents the wasting of truck power; cushioning effect, which keeps the main-

*Journal of American Society of Mechanical Engineers.

tenance charges low on the whole truck; a good tractive grip and a reasonable cost all are properties which are required in a truck tire.

Operating Costs.—Fig. 2 gives a graphical view of percentage costs for a light, a medium and a heavyweight truck, each averaging 50 miles a day. The higher proportion which the light truck has in the items of labor, depreciation and maintenance is noticeable. Against this increase is the lower percentage of the entire cost charged to fuel and tires.

Many of the larger department stores will not allow their drivers to make any repairs or even to carry a

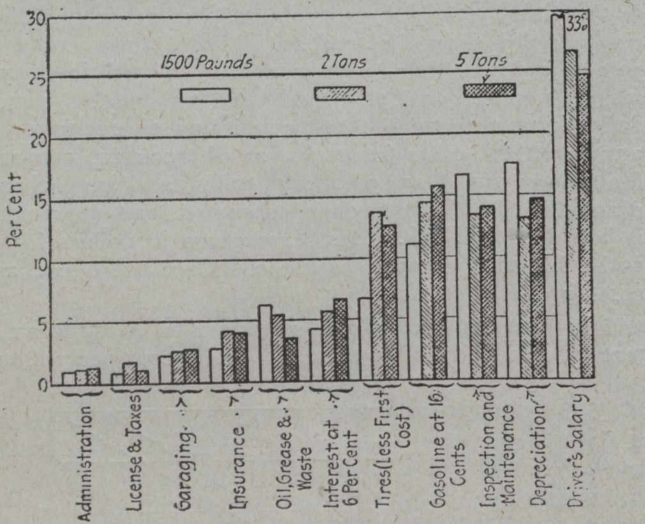


Fig. 2.—Division of Truck Costs.

wrench or a pair of pliers. A regular force looks after each truck and keeps it cleaned, oiled and set up. Ownership of eight or ten trucks will justify an owner in employing a mechanic who, with a small outfit of tools and a helper, can keep the trucks clean and in adjustment and make many of the smaller repairs. Reliable service garages are now to be found which will do the same work for a reasonable charge, and this is more satisfactory than to leave it to the driver.

It is impossible for the manufacturer to devise a shop test that will equal the brutality of actual service. The modern motor truck has had to meet the demand for a vehicle that will stand abuse. The careless or indifferent driver is quick to find this out. Operating costs for the same make and capacity of truck engaged in exactly the same kind of work for one firm will frequently show a variation of 40 per cent. in the items of gasoline, oil, tires and maintenance. It is easy to see how a poor driver will shorten the life of a truck.

Manufacturers have tried to meet this condition by making truck parts as few and simple as possible; by standardization of parts; by making wrong assemblies impossible; by printing detailed information about oiling and caring for the truck; and by instituting a follow-up service to get the truck owner started right. The truck governor has helped to solve the speeding problem. Another aid is the recording speedometer, which gives a graphical log of each day's run—velocity plotted against time: thus every minute of the day is accounted for; the number of stops and time of each, maximum speed, etc. The chart will show, for example, whether it will pay to put on a second man to hasten deliveries or whether a re-routing of existing lines will give a better all-round service. A driver's record sheet, if it is brief and informing and filled out each day, is frequently helpful. It must be drawn off at the office and kept up to date. Records are of little use unless changed conditions can be recognized at once.

Lubrication is probably the most important item in truck maintenance. Manufacturers have tried to make oiling simple and easy to do by making oiling places few and accessible, and by providing charts and printed instructions for this work; some parts every day, some parts twice a week, etc. Still, there are about seventy places in the average truck that must be lubricated, and if there is no intelligent head to look after this work local wear soon starts, and then things go fast. Motor oil should be changed frequently, at least once for every 1,000 or 1,500 miles' run. It is not enough to build up the supply, as the oil is fast charged with carbon and with grit from the intake air and soon loses its lubricating qualities.

Fig. 3 gives curves for gasoline trucks plotted from the data of Table I. These curves, if continued out to the line of zero miles per day, show the daily fixed charges for each truck. The cost per day increases quite uniformly with the increase in size of the truck, whether the daily run be a large or a small one. The cost per ton-mile is based on a full load each way. This chart shows that under such favorable conditions of haulage a heavy truck may reach a ton-mile cost of as low as 5 cents, provided that the nature of the work is such that the truck can be run daily at the rate of 50 or 60 miles a day. This is a heavy mileage for a big truck, and such an ideal service as would be represented by a full haul each way on level roads, with loading and unloading time minimized so that the truck could be under way for six or seven hours each day and with no extra helper required, is not often found.

In deciding upon a truck one of the most important questions to settle is that of size. On the good roads of this section it is more disastrous to buy a truck too large for the work than to buy one that is too small. A 5-ton truck costs some 25 per cent. more to operate than a 3-ton machine, nor is this cost reduced very much by taking a lighter load on the heavier truck. Interest, depreciation, maintenance, taxes, insurance and fuel—all are higher. Until very recently the tendency has been for

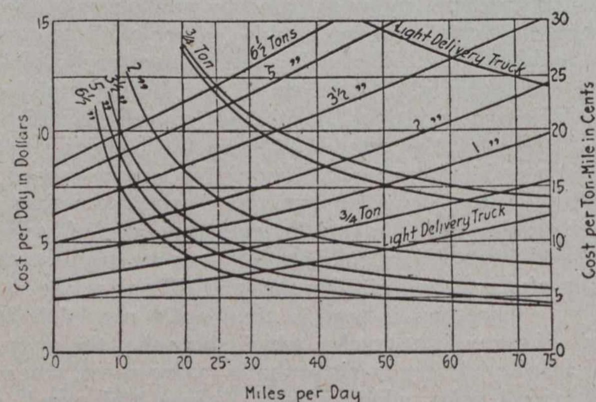


Fig. 3.—Cost of Operating Gasoline Motor Trucks.

owners to buy trucks too large for their needs. Now the buyers have commenced to realize that it costs too much to "deliver the vehicle."

Another point that must not be overlooked is that the capacity of a truck is figured for average conditions, and that the average road condition throughout the country is very much harder on the truck than it is here. A half load on a truck carried over a road full of ruts and chuckholes is much worse for the truck than a 20 per cent. overload on a good concrete or asphalt road. A 6½-ton truck recently carried an 11-ton casting up the Mount Wilson toll road, a distance of 9 miles. This is a tremendous overload, but it cannot be said that the truck was injured by it. In fact, it is probable that the truck parts were not weakened in any way by this test, for the road, while steep, is firm and smooth. The writer does not wish to encourage overloading, which has been responsible for many truck failures and against which much has been written, but he does wish to point out that an occasional overload of 25 per cent. or even 50 per cent. when handled carefully on a good road is not a serious matter, while to haul a heavy truck day after day, loaded at half capacity, is a very serious matter if one would haul cheaply.

It is possible to buy a truck that is suited for work on good roads or one that is especially designed for rough roads, mud, steep hills and severe service generally. The problem is to know what is suited and to weigh properly the arguments of the salesman who offers a 2-ton truck with a 15-h.p. motor and a 25-h.p. rear axle, and the counter arguments of his rival, whose truck has a 25-h.p. motor and a 20-h.p. rear axle. This is one of the surprising results of the modern method of building up assembled parts into a truck, and, while there may be advantages of such variations in the relative strength of truck parts for some particular service, it is a fact that both extremes are being sold for exactly the same work. The Society of Automobile Engineers has done a wonderful work in standardizing the parts for auto trucks. This will be carried much further in the future, for the economies that will result from standardized parts and also from standardized assemblies have been strongly emphasized by the experience of European countries with the use of trucks in the present war.

At present the truck owner or prospective purchaser is sadly in need of disinterested advice, and there is a good engineering field for the man who thoroughly knows trucks and can plan service. There is little doubt but

Table I.—Total Cost of Operating Gasoline Motor Trucks at Various Daily Mileages.

								Costs for entire life of truck, in dollars.														
Capacity of truck.	Cost in dollars.	Horsepower.	Miles per hour.	Miles per gallon of gasoline.	Daily mileage.	Estimated life, years.	Total mileage.	Insurance, fire and liability.	License and taxes	Interest at 6 per cent.	Depreciation.	Administration.	Garaging.	Gasoline at 16 ct. per gal.	Oil, grease and waste.	Tires (less first cost).	Driver's salary.	Inspection and maintenance.	Total.	Cost per day, dollars.	Cost per mile, dollars	Cost per ton-mile, dollars.
Light delivery wagon	600	18	25	15	25	5	37,500	200	40	180	600	35	180	400	190	225	2,400	750	5,200	3.47	0.139	0.417
					50	2½	37,500	100	25	90	500	20	90	400	190	225	1,200	655	3,495	4.66	0.096	0.288
					75	1½	33,750	60	20	55	450	10	55	360	170	200	900	505	2,785	6.19	0.082	0.246
1,500 lbs.......	1,100	22	20	12	25	6	45,000	300	65	400	1,100	110	215	600	340	270	3,600	1,010	8,010	4.45	0.178	0.237
					50	3	45,000	150	50	230	950	55	110	600	340	270	1,800	900	5,455	6.06	0.121	0.161
					75	2	45,000	100	30	130	850	35	70	600	340	270	1,440	790	4,655	7.76	0.103	0.137
1 ton.........	1,875	24	19	8	25	10	75,000	850	220	1,125	1,875	225	480	1,500	560	1,340	7,200	1,900	17,275	5.76	0.230	0.230
					50	6½	97,500	550	140	730	1,690	140	310	1,950	730	1,800	4,680	1,900	14,620	7.50	0.150	0.150
					75	4	90,000	300	85	395	1,500	90	170	1,800	675	1,640	3,468	1,800	11,815	9.85	0.131	0.131
1½ tons......	2,150	25	18	7	25	10	75,000	1,000	235	1,290	2,150	255	600	1,710	560	1,505	7,200	2,000	18,505	6.17	0.247	0.165
					50	6½	97,500	650	150	840	1,935	170	390	2,230	730	2,025	4,680	2,000	15,800	8.10	0.162	0.109
					75	4	90,000	350	95	450	1,725	100	210	2,055	675	1,850	3,360	1,900	12,770	10.64	0.142	0.095
2 tons........	2,625	26	17	6	25	10	75,000	1,150	265	1,575	2,625	315	720	2,000	750	1,840	7,200	2,250	19,440	6.90	0.276	0.138
					50	6½	97,500	750	195	1,025	2,360	205	470	2,600	975	2,475	4,680	2,250	17,985	9.22	0.184	0.092
					75	4	90,000	400	110	550	2,100	125	250	2,400	900	2,255	3,360	2,100	14,550	12.12	0.162	0.081
3½ tons......	3,500	32	14	5	25	10	75,000	1,350	380	2,100	3,500	415	960	2,400	750	2,345	9,600	3,250	25,700	9.02	0.361	0.103
					50	6½	97,500	875	245	1,365	3,150	270	625	3,120	975	3,150	6,240	3,250	23,265	11.93	0.239	0.068
					75	4	90,000	460	150	735	2,800	165	335	2,880	900	2,870	3,840	3,000	18,135	15.11	0.201	0.057
5 tons........	4,600	35	12	3½	25	10	75,000	1,760	440	2,760	4,600	550	1,200	3,430	750	2,680	10,800	4,000	32,970	10.99	0.439	0.088
					50	6½	97,500	1,145	285	1,845	4,140	360	780	4,460	975	3,600	7,020	4,000	28,610	14.67	0.297	0.059
					75	4	90,000	300	180	965	3,680	220	480	4,115	900	3,280	4,320	3,600	22,340	18.62	0.223	0.044
6½ tons......	5,000	40	10	3	25	10	75,000	1,875	525	3,000	5,000	590	1,320	4,000	940	3,015	10,800	5,000	36,065	12.02	0.481	0.074
					50	6½	97,500	1,220	350	1,950	4,500	380	860	5,200	1,220	4,050	7,020	5,000	31,750	16.35	0.326	0.050

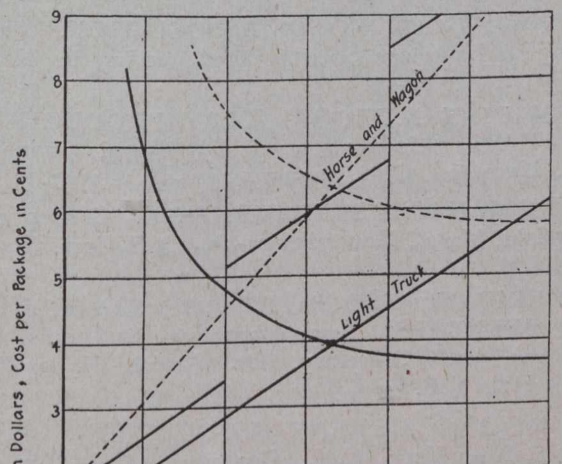


Fig. 4.—Comparison of Single Horse and Wagon and Light Delivery Truck Costs.

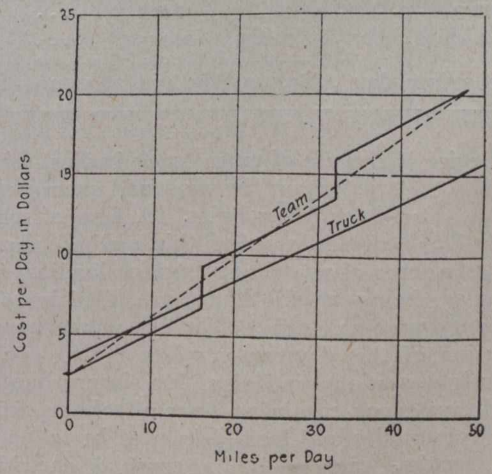


Fig. 5.—Comparison of Costs for 5-Ton Gasoline Truck and Heavy Teams.

that the average truck owner could save 20 per cent. of his operating costs by properly analyzing his problem.

Methods of Reducing Trucking Costs.—To get a low cost per ton it is necessary to keep the truck moving. Devices which cut down the time of loading and unloading are very important. Among these are self-dumping bodies of various kinds for stone, hot asphalt or lumber; loading chutes or bins which are filled by elevator or conveyer; there is also a movable steel tipple which can be run alongside a train of flat cars and be filled by shovelers while the truck is out on the road, so that the actual time required to fill the truck is very little.

Table II.—Comparison of Operating Costs of a Single-Horse Wagon and a Light Gasoline Delivery Truck.

Cost of wagon equipment (horse, $250; wagon, $140; harness, $40), $430.

Cost of 700-lb. capacity gasoline truck, $600.

	Wagon costs. Idle.	Wagon costs. 20 miles per day.	Truck costs. Idle.	Truck costs. 60 miles per day.
Estimated life, years ..	10	10	10	2.5
Depreciation	$0.108	$0.156	$0.200	$0.760
Interest at 6 per cent...	0.086	0.086	0.120	0.120
Taxes	0.009	0.009	0.012	0.012
Stable and garage rent	0.200	0.200	0.166	0.166
Insurance (fire and theft)	0.030	0.030	0.045	0.045
Driver (1/3 time when idle)	0.666	2.000	0.666	2.000
Feed—				
Hay, 10 lb. and 15 lb.	0.102	0.153	....	....
Oats, 10 qt. and 15 qt.	0.200	0.300	....	....
Gasoline, at 16c. per gal.	....	....	....	0.640
Lubricating oil, at 40c.	....	....	....	0.130
Hostler (1 man to 12 horses)	0.200	0.300	....	....
Cleaning and oiling ...	....	....	....	0.400
Shoes and veterinary ..	0.095	0.135	....	....
Tires and tubes	....	....	....	0.625
Repairs to wagon	....	0.090	....	....
Maintenance	....	....	....	1.200
Water, bedding, etc. ..	0.045	0.045	....	0.005
Total cost per day ..	$1.741	$3.404	$1.209	$6.103

Another device is the use of extra truck bodies, which are loaded while the truck is on the road and swung onto the truck by an air lift or other hoist. A firm of wholesale grocers in Los Angeles is using this method very satisfactorily. In interurban delivery service loading nests or cartridges are being used. These are filled in the store and run out onto the truck. There is some promise in the extension of this device for relieving the congestion around freight stations and also for interurban service where a heavy truck can bring over all of the orders for an entire community and local deliveries be taken care of by light trucks, each with its especial cartridge. A scheme somewhat similar to this is now being tried out by the city of Los Angeles. The incombustible rubbish is gathered by a house-to-house collection, using wagons. The material is put in large cans which are carried to a central point and a heavy truck is used to haul all of the cans to the city dump.

Comparisons of Operating Costs of Horse-drawn and Motor Trucks.—The use of an extra man to facilitate deliveries will often save enough time to make a good investment. Ont of the large department stores in Los Angeles found that on a certain route where one man had averaged 110 stops a day two men were able to make 190 deliveries. The use of self-starters on trucks of this type is also becoming common. These save a little time on each stop and also keep the driver out of the dirt, and particular customers appreciate this feature. At the plant of the Southern California Gas Company the night man unloads the trucks and stores the pipe and old meters that have been collected during the day, and then puts onto the truck the new supplies that have been requisitioned for the coming day.

Fig. 4 and Table II. show a comparison between the cost of running a light gasoline delivery truck such as is used for close-in delivery work by grocers and the cost of running a one-horse delivery wagon. The costs are from actual costs gathered in Los Angeles and vicinity and averaged. For each vehicle the cost is figured for the vehicle idle and again when running at a fair maximum daily average. The figures show that there is no excuse for using a horse for this kind of work, whether the number of deliveries be large or small. Twenty miles a day is a maximum for any delivery horse if used 300 days a year. If more than 20 miles a day are to be covered, it is necessary to duplicate equipment.

COMING MEETINGS.

AMERICAN MINING CONGRESS. In Chicago, November 13. Secretary, J. F. Callbreath, Munsey Bldg., Washington, D.C.

NATIONAL COMMERCIAL GAS ASSOCIATION. Convention in Atlantic City, N.J., November 13-18. Secretary, Louis Stotz, 61 Broadway, New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS. Convention in Washington, D.C., November 14. Secretary, W. H. Connolly, Washington.

KANSAS GOOD ROADS ASSOCIATION. Annual meeting in Lawrence Society headquarters in Kansas City, November 16-17.

CANADIAN NATIONAL CLAY PRODUCTS ASSOCIATION. Convention at the Royal Connaught Hotel, Hamilton, Ont., January 23rd-25th, 1917.

CITY MANAGERS' ASSOCIATION. Convention in Springfield, Mass., November 21-23. O. E. Carr, Niagara Falls, N.Y.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS. Annual meeting, St. Louis, Mo., December 5-7. Secretary, Dr. Joseph Hyde Pratt, Chapel Hill, N.C.

PORTLAND CEMENT ASSOCIATION. Annual meeting, New York, N.Y., December 11-13. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

WESTERN PAVING BRICK MANUFACTURERS' ASSOCIATION, Kansas City, Mo., January 20th, 1917. Secretary, G. W. Thurston, 416 Dwight Bldg., Kansas City, Mo.

AMERICAN ROAD BUILDERS' ASSOCIATION. Fourteenth Annual Convention; Seventh American Good Roads Congress under the auspices of the A.R.B.A., and Eighth National Good Roads Show of Machinery and Materials, Mechanics' Hall, Boston, Mass., February 5-9, 1917. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.

TENTH CHICAGO CEMENT SHOW, Coliseum, Chicago, Ill., February 7-15, 1917. Secretary, Blain S. Smith, 210 South La Salle Street, Chicago, Ill.

WOOD BLOCK PAVING SPECIFICATIONS.

(Continued from page 378.)

clean sand into them, after which the surface shall be covered to a depth of about ½ inch with fine sand. This sand is to be left upon the pavement for such a time as may be directed by the city, after which it shall be swept up and taken away by the contractor.

When the blocks are laid on streets having grades of 3 per cent. or over, it is desirable that the blocks be spaced by laying creosoted wood lath of about 5/16 inch thick between each course. The space above the lath shall then be filled with heated, crushed stone (containing no dust) and bituminous filler as specified above. The bituminous filler shall first be poured into the bottom of the joint, care being taken to get none on the surface of the pavement. The crushed stone shall then be swept into the joint and the space around the stone filled with the bituminous filler to the top of the joint. It is essential in open-joint pavement to drive the blocks together every four rows to prevent tipping of the individual blocks.

[NOTE.—Here are inserted the methods of sampling and testing of preservatives that were described in the Society's proceedings for the year 1915.—Editor.]

COKE TEST.

In making the coke determination, hard glass bulbs are to be used. The test is to be carried out as follows:—

Warm the bulb slightly to drive off all moisture, cool in a desiccator and weigh. Again heat the bulb by placing it momentarily in an open Bunsen flame and place the tubular underneath the surface of the oil to be tested and allow the bulb to cool until sufficient oil is sucked in to fill the bulb about two-thirds full. Any globules of oil sticking to the inside of the tubular should be drawn into the bulb by shaking or expelled by slightly heating it, and the outer surface should be carefully wiped off and the bulb reweighed. This procedure will give about one gram of oil. Cut a strip of thin asbestos paper about one-quarter inch wide and about one inch long, place it around the neck of the bulb and clutch the two free ends close up to the neck with a pair of crucible tongs. The oil should then be distilled off as in making an ordinary oil distillation, starting with a very low flame and conducting the distillation as fast as can be mantained without spurting. When oil ceases to come over, the heat should be increased until the highest temperature of the Bunsen flame is attained. the whole bulb being heated red hot until evolution of gas ceases and any carbon sticking to the outside of the tubular is completely burned off. The bulb should then be cooled in a dessicator and weighed, and the percentage of coke residue calculated to water-free oil.

FLOAT TEST.

Method.—The float apparatus consists of two parts, an aluminum float or saucer, and a conical brass collar. The two parts are made separately, so that one float may be used with a number of brass collars.

In making the test the brass collar is placed with the small end down on the brass plate, which has been previously amalgamated with mercury by first rubbing it with a dilute solution of mercuric chloride of nitrate and then with mercury. A small quantity of the material to be tested is heated in the metal spoon until quite fluid, with care that it suffers no appreciable loss by volitalization and that it is kept free from air bubbles. It is then poured into the collar in a thin stream until slightly more than level with the top. The surplus may be removed after the material has cooled to room temperature by means of a spatula or steel knife, which has been slightly heated. The collar and plate are then placed in one of the tin cups containing ice water maintained at 5° C., and left in this bath for at least 15 minutes. Meanwhile the other cup is filled about three-fourths full of water and placed on the tripod, and the water is heated to any desired temperature at which the test is to be made. This temperature should be accurately maintained, and should at no time throughout the entire test be allowed to vary more than one-half a degree centigrade from the temperature selected. After the material to be tested has been kept in the ice water for at least fifteen minutes, the collar, with its contents, is removed from the plate and screwed into the aluminum float, which is then immediately floated in the warmed bath. As the plug of bituminous material becomes warm and fluid, it is gradually forced upward and out of the colar until water gains entrance to the saucer and causes it to sink.

The time in seconds between placing the apparatus on the water and when the water breaks through the bitumen is determined by means of a stop-watch and is taken as a measure of the consistency of the material under examination.

INTERNATIONAL NICKEL COMPANY.

When the plans for its proposed construction and improvement work in Canada have been completed the International Nickel Company will have increased its capacity approximately 40 per cent., or from an annual output of 60,000,000 pounds of nickel to between 80,000,000 and 90,000,000 pounds.

Original plans called for the expenditure of $2,000,000 on a Canadian refinery. The management, however, decided later to increase facilities all along the line through a single appropriation, and $5,000,000 was then decided upon as the prospective investment. The refinery will cost about $2,000,000. Smelting facilities at the Canadian Copper Works will be enlarged and water-power capacity will be increased.

The nickel company handles about 850,000 tons of ore annually, the average grade of which runs about 4½ per cent. nickel. Copper values average about one-half the nickel content, or 2¼ per cent. The company saves about 92 per cent. of the nickel.

The nickel turned out in the Canadian plant will be for the use of Great Britain and its dominions. This output, it is estimated, will be from 20,000,000 to 30,000,000 pounds a year. With an increase in nickel output copper yield is expected to automatically increase from about 30,000,000 pounds to better than 40,000,000 pounds per annum.

In the course of a discussion on the metric system, held by the Boston Society of Civil Engineers, the opinion was expressed that it is quite possible that Great Britain will bring about the completion of the metric reform sooner than the United States will.

The Housing Commission of the Corporation of Dublin, Ireland, decided to recommend the acceptance of a loan of $2,000,000 at 5 per cent. offered by Lee, Higginson and Company, of Boston. The offered loan is for the reconstruction of the city on plans approved by the Housing and Town Planning Association of Ireland. Late in August, John Nolan, of Cambridge, Mass., one of the three adjudicators appointed by the association, approved plans for the rebuilding of Dublin.

IMPORTANCE OF MAINTENANCE IN SELECTING PAVEMENTS.*

By C. D. Pollock,
Consulting Engineer, New York City.

INVESTIGATION shows that very few of our cities, counties or states give any real consideration to the maintenance costs in deciding upon proper pavements for streets and roads. Even a cursory examination of the various reports shows this matter to be greatly neglected. Many cities have appropriations for repairs. These appropriations are always used, but the reports do not show the actual conditions as to whether the various streets were kept in good repair, or whether the money was simply spent and holes were fixed as far as the money would go, and the rest were left to be done with another year's funds. Unless these facts are known, it is impossible to compare maintenance costs and arrive at any true results.

Many of our cities possess experienced engineers to draw specifications for, and to supervise, the construction of new pavements, and they get good pavements of their kind; but the authorities think that the work of the engineer is done when this has been accomplished. In other words, the idea seems to prevail that when a pavement is laid, the engineer is through and that any politician with a good following can do the rest. As a result, the maintenance work and the replacing of pavement over corporation and plumbers' cuts are very often under a man who is known as superintendent of streets, or of repairs, or has some similar title, and whose only qualification is that he was a good worker in the last campaign. He may do the best that he can, and then again he may only see that a maximum number of voters are given employment in making alleged repairs to the pavements. Such a man will probably keep track of the cost of repairs by weeks, months or years, but will have no idea of keeping costs by streets, blocks or contracts; and as a consequence his costs will mean nothing to him or anybody else, except that he has had an appropriation and has spent it where he thinks it will do the most good (at the next election?).

By this method the engineer who laid the original pavements will have gained no knowledge as to the real costs of his pavements, and consequently will be in no better position to judge whether he should continue to lay the same kinds of pavements under similar traffic conditions, or whether he should select more durable materials for those conditions. The best that he can do is to judge by casual observation, which in the case of most busy municipal engineers can be of the most general character at best.

The above seems to be the rule rather than the exception in this country, and applies not only to municipalities, but also to our county and state highways as well. Some of the State Highway reports of neighboring states furnish a great amount of data to illustrate this point if one takes the trouble to dig it out, but the work is so divided and the reports are from so many different officials, that nothing can be learned without a large amount of labor.

One nearby state which continues to lay mainly water-bound macadam, even upon main arteries of travel, shows in its report (or rather it does not show, but by spending considerable time in the study of the various sections of the report, it was found) that, with the first cost of the macadam and the repairs to this in a period of six years, the total cost per square yard was considerably more than would have been the cost of laying the same width of granite block pavement on a concrete foundation in the first place and making the additional provision for the sinking fund. At the end of the six years the reports gave the condition of the roads as bad even with the large sums spent in repairs. This was applicable to some thirty or more of the main travelled roads, between important towns and cities. This search could be carried further, to include many more roads where a cheaper form of pavement, yet a more substantial one than water-bound macadam, could have been used, with much economy from the standpoint of maintenance.

The remedy for this condition is to continue to employ experienced paving engineers on the original construction of the pavements and then put the maintenance under the same engineer. If this is done, the engineer will watch his pavements carefully, also his maintenance costs, and will observe when he requires a more substantial form of pavement under certain traffic conditions, and also when he has the proper pavement for those conditions. In other words, he will keep careful account of the cost of maintenance of the various pavements together with the traffic each bears, and then he will be in a position to make his deductions as to when to use this kind of pavement and when to use another kind. With the present method of divided responsibility as prevails in so many of our cities, this is impossible.

The all-important point is to place the new construction and the maintenance under one engineering head and then hold him responsible for results; and if he is given the authority, he will get results far superior to those now obtaining.

*Paper before American Society of Municipal Improvements.

TO MANUFACTURE STEEL WHEELS.

The Hamilton Steel Wheel Company has purchased a site and will erect a plant costing $200,000, for making steel wheels, which product was formerly furnished by Germany and the United States.

This industry will give employment to about 200 men and will turn out about 75 tons of steel wheels per day.

C. W. Sherman, of the Dominion Steel Foundry Company, will be managing director of the new concern.

SEATTLE DRYDOCK TO BE LARGEST IN THE WORLD?

The Seattle Construction & Drydock Company announced on October 28th that the contract for the first four sections of its new floating drydock would be let to John McAleer for $225,000.

The new drydock, even the first four sections, when completed, will be the largest floating wooden drydock in the world, according to shipping experts, and will be capable of handling vessels up to 500 feet in length. The lifting capacity will be 12,000 tons.

Through the closing of the deal for the construction of the four units comes the further news that instead of a drydock with a limit of 12,000 tons, two additional sections will be added in the near future, giving a total capacity of 20,000 tons, enough to handle the largest ships plying on the Pacific Ocean. The length limit will be 650 feet.

Because of the size of the big sections, 88 by 136 feet, they will be built at Port Blakely and then towed to Seattle. The first four sections, when completed, will cost $500,000.

The new Trolpasttz Canal in Sweden has been opened by King Gustave. The canal establishes communication between Wener Lake and the North Sea, and seven years was spent in its construction.

Editorial

THE ENGINEER AND PUBLIC SERVICE.

It remained for the war to bring into proper perspective the real worth of the engineer, and to show the world in an adequate manner the important part the profession has had to play in such convulsions as those through which we are now passing.

Not alone in times of war is the engineer a most necessary element in the world's conduct, but in times of peace the part he has to play in the carrying on of governmental administration is becoming more and more patent to all observers. When one considers how large a proportion of the money spent by federal, provincial and municipal governments is spent on work which either directly or indirectly calls for engineering supervision of some kind or another, it will easily be seen that the engineer must continue to take an ever-increasing interest in the affairs of governments. Public health, city planning, water supply, lighting, roadways, sewerage and sewage disposal, street railways and many other branches of government, all come directly into the realm of the engineer.

In view of all this, it is but reasonable to expect that the engineering profession, alive to the problems with which governments of all kinds are confronted, will respond to the challenge and assume that share of responsibility that rightly belongs to it. If this is done, more effective results in public administration are assured. The trained engineer, with his analytical mind, his power to obtain facts and his determination to stand by them, his tendency to act with precision, all fit, or should fit, him for a larger and more important part in public service.

Looking backward, it must be admitted that during the past few years the engineer has been coming into his own more and more, so far as governmental and administrative affairs are concerned. For instance, there is the introduction of the city manager form of government, the manager or commission-manager in the great majority of cases being an engineer by profession. The growth of bureaus of municipal research and many other developments suggest the possibilities which public service is opening to the engineer who, with a trained mind, an inventive genius, the creative instinct fully developed, is anxious to place at the disposal of his fellow citizens all those qualifications which eminently fit him for a larger place in administrative affairs of the community.

INDUSTRIAL RESEARCH IN CANADA.

In an address before the Royal Canadian Institute, Professor J. C. McLennan, of the University of Toronto, last week advocated more systematic and intelligent efforts to develop and encourage industrial research in Canada after the war. He said that the three chief sources of wealth in the Dominion are agricultural lands, electrical power and mineral deposits. He cited some instances of firms in England having imported raw material which was found, after the war had cut off the other supply, to be at their very doors. He thought the same thing might be applicable to opportunities in Canada.

Prof. McLennan advocated a consolidation and correlation of the research work now being carried on at Ottawa in different departments and under different ministers. He also urged that the facilities afforded by the universities should be supplemented by the establishment of physical and chemical bureaus in the centre of those localities where industrial activity is greatest.

If industrial research in Canada is to be effective, there must be a more sympathetic attitude on the part of manufacturers, scientific institutions and the government toward this important work.

EXPORT TRADE

One month after war commenced, our merchandise exports for the 12 months previous, had a value of $468,000,000. At the end of September last, the year's export trade had increased to $1,053,000,000. When war commenced our total trade for the previous year was $1,061,000,000. At the end of the 12 months ended September last, it was $2,014,000,000. The importance of permanent and steady export trade is becoming recognized here only slowly. The growth in this trade by 103 per cent. during the war period is due chiefly to war orders in Canada, the value of which has exceeded $1,000,000,000 since the commencement of the struggle. The large crop last year also contributed to the expansion of trade.

How our exports were made up for the 12 months ended September, 1914, and 1916, is shown in the following table:—

Canadian produce.	1914.	1916.
The mine	$ 57,174,939	$ 77,436,746
The fisheries	19,964,899	23,274,772
The forest	42,191,112	53,952,950
Animal produce	62,034,576	111,331,332
Agricultural products	179,110,844	396,455,537
Manufactures	63,355,893	361,381,419
Miscellaneous	224,830	8,107,248
Total Canadian produce	$424,057,093	$1,031,940,004
Foreign produce	44,152,917	20,985,647
Total exports (merchandise)	$517,982,240	$1,052,925,651

The increase of 473 per cent. in the export of manufactures is a direct result of war orders. The production of our factories during 1916 will probably be at least $2,000,000,000 as compared with $1,110,000,000 in 1910. While factories are working at full capacity now, the demand is abnormal and will to a large extent cease shortly after peace comes. The domestic market will absorb a substantial part of our factory products after the war, but it is the marketing of the surplus which requires the serious consideration of manufacturers, and now. The success or failure in placing this surplus in foreign markets will maintain or depress Canadian export trade. The maintenance of export trade during peace times is one of the most important questions of the day. Competing in the home market, and filling foreign war orders, are entirely different things to competing abroad in normal times.

PERSONAL.

WILLIAM JOHN PICKRELL has been appointed assistant superintendent of district 1, eastern division, C.P.R., Farnham, Que.

D. D. FRASER, of Butte, Mont., has joined the engineering staff of the Highland Valley Mining and Development Co., at Ashcroft, B.C.

GEO. KIDD, general manager, British Columbia Electric Railway, returned to Vancouver recently after a three months' official trip to England.

C. H. RUST, city engineer, Victoria, B.C., recently addressed the Rotary Club of that city and described interesting features of the sewer and waterworks systems.

Prof. WILLIAM NICOL, for a quarter of a century professor of mineralogy at Queen's University, Kingston, Ont., has resigned owing to illness, and will reside in Los Angeles, Cal.

H. H. TRIPP, formerly resident engineer of the Canadian Pacific Railway at Winnipeg, has been appointed resident engineer at Kenora, Ont., vice H. J. BLACK, transferred.

Lieut.-Col. BLAIR RIPLEY, commanding officer, No. 1 Construction Battalion, and formerly engineer of grade separation, C.P.R., North Toronto, has arrived in England with his battalion.

A. G. McINTYRE, formerly general manager of the Mattagami Pulp and Paper Co., Limited, Toronto, has been appointed special representative of the committee on paper of the American Newspaper Publishers' Association.

A. S. DAWSON, M.Can.Soc.C.E., chief engineer, and R. S. STOCKTON, superintendent of irrigation, natural resources department, C.P.R., Calgary, Alta., attended the irrigation convention at El Paso, Texas, in October.

A. J. STEVENS, M.Can.Soc.C.E., formerly in charge of the Dominion Public Works, Manitoba District, has been transferred to Windsor, Ont., to relieve H. J. LAMB, M.Can.Soc.C.T., who is in the Canadian Expeditionary Force.

D. McNICOLL, formerly vice-president and a director of the C.P.R., who, owing to illness, spent the summer at his son's ranch, Penticton, B.C., has returned to Montreal where, it is said, he is to undergo special medical treatment.

E. H. NIEBEL, B.A.Sc., superintendent of light, power and telephones for the town of Melfort, Sask., has resigned to rejoin the organization of the Northern Electric Company at Regina. He will be succeeded by W. B. HARRISON, of McTaggart, Sask.

W. A. DUFF, A.M.Can.Soc.C.E., engineer of bridges, Canadian Government Railways, Moncton, N.B., has been appointed assistant chief engineer. He will continue to perform the duties of engineer of bridges and will have charge of the Halifax ocean terminals.

Lieut. HARRY ROY URIE, of the 3rd Tunnelling Company, Canadian Engineers, and Flight Lieut. ERNEST DORLAND HICKS, members of the Faculty of Engineering and Architecture of Manitoba, were both awarded the Military Cross on September 26th for bravery while in action.

D. R. CAMPBELL, assistant general manager, Pacific Division, Canadian Northern Railway, was reported to be convalescent, about the middle of October, after a sudden illness which necessitated several weeks' stay in the hospital at Kamloops, B.C. He is now at his home in Vancouver, B.C.

GEORGE A. CUNLIFF, of Brandon, Man., has been appointed superintendent of the third district, western division, Canadian Northern Railway at Edmonton, Alta., in succession to J. C. O'DONNELL, who has been appointed superintendent of the second district, central division, with headquarters at Winnipeg, Man.

P. J. FLYNN, divisional superintendent of the Canadian Northern Railway at Winnipeg, has resigned, having accepted a position on an American road. Mr. Flynn came from Chicago to be superintendent of the Union Terminals here, and held this position till about two years ago, when he became superintendent of the Canadian Northern Railway.

E. L. COUSINS, A.M.Can.Soc.C.E., general manager, Toronto Harbor Commission, has declined to act for the Montreal city council in reference to the street railway problem there on account of the extra demands on his time caused by the large number of the commission's staff who have gone into the Canadian Expeditionary Forces.

J. S. DENNIS, assistant to the president of the C.P.R., Lord Shaughnessy, as head of the company's department of natural resources, with office at Calgary, Alta., has been transferred to Montreal as assistant to Lord Shaughnessy, with special duties in connection with colonization and the development of Canada's resources adjacent to the company's system. P. L. NAISMITH, who has been manager for some years, succeeds Mr. Dennis at Calgary.

FRANK GOODMAN, of Toronto, was operated upon last Saturday at the Western Hospital, Toronto, for appendicitis and complications therefrom. His condition was serious for a couple days after the operation, but complete recovery is now assured. Mr. Goodman is well known to the city engineers of Canada, as he is most energetic upon behalf of the manufacturers with whom he is connected. Among other lines he represents United States makers of brick, paving joints and wood block.

OBITUARY.

JOHN AYLEN, an Ottawa civil engineer who had been working on the Hudson's Bay Railway, was found dead recently in a Winnipeg hotel. He was fifty years of age.

W. T. WOODROOFE, formerly superintendent of the Edmonton Municipal Railway, who went overseas some time ago with the Canadian Expeditionary Force, is reported to have been killed in action.

S. PARKER TUCK, who died at Nelson, B.C., recently, was associated with the building of a section of the Canadian Pacific Railway from Yale, B.C., westward, and was in charge of the work from Lytton to Spence's Bridge.

VIRGIL G. BOGUE, noted American engineer, who prepared the plans for the Rogers Pass tunnel for the Canadian Pacific Railway Co., and who also made plans for the development of the terminal and waterfront improvements at Prince Rupert, B.C., for the Grand Trunk Pacific Railway, died recently while on his way from Mexico to New York. The deceased was born in Norfolk, N.Y., July 20, 1846, and was graduated from the Rensselear Polytechnic Institute at Troy, N.Y., in 1868. He was a member of the American Society of Civil Engineers, American Institute of Consulting Engineers, Western Society of Engineers, American Railway Engineering Association, Franklin Institute of Philadelphia, and the Geographical Society of Peru, S.A.