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The Canadian Engineer

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ACTIVATED SLUDGE EXPERIMENTS AT MILWAUKEE.

SOME FURTHER INTERESTING FACTS CONCERNING THE PROCESS BROUGHT OUT BY THE EXPERIMENTAL WORK CARRIED OUT AT MILWAUKEE.

By R. O. WYNNE-ROBERTS, M.Can.Soc.C.E.

In a previous article on this subject in the issue of April 27th attention was paid to the general results obtained at Milwaukee. There were, however, many additional interesting investigations made into different features of the process. These included the efficient diffusion of air, period of aeration, and volume of air required, effects of temperature, production and dehydration of sludge, inoculation of sewage with activated sludge, and so on, all of which are valuable studies and tend to render the process more efficient and economical. Most of these are confirmatory or enlargements of experiments made by Messrs. Ardern and Lockett in 1914.

Diffusion of the air in the sewage has been experimented upon by means of filtros plates, monel metal, and air jets. Filtros plates are made of quartz sand cemented together and baked, and are supposed to be made of any porosity desired. But, out of 530 plates, each 1 ft. square, only 60 per cent. complied with the specification that 2 cu. ft. of air per minute be passed through each dry plate 1½ ins. in thickness, under a pressure of 2 ins. of water, with a marginal allowance of 5 per cent. either way. When the plates are wet the pressure increases 10 to 12 times. For example, with 8 ft. of liquor the filtros plates required 4.6 lbs., that is, 1.12 lbs or 31 ins. in excess of the static head, or 15 times the pressure required when the plates are dry. Mr. Chalkley Hatton states that the bubbles were too large to produce the greatest efficiency. He expresses the opinion that the excess pressure might be reduced by making the plates thinner and reinforcing them like wired glass. He found that when the air bubbles were 1/16 in. or less in diameter they were in contact with the liquor in a 10-ft. deep tank from one to four minutes, but when the diameter of the bubbles exceeded the above dimension the contact was only but a few seconds. The economy in the use of air is to be attained by prolonging the contact until the oxygen has been absorbed, but the problem is to secure such prolonged contact. "Several mechanical devices have been designed and operated to break the air globes into smaller globes, but so far they have not been satisfactory."

Mr. Copeland states that filtros plates are very irregular in porosity. Some would pass 10 ft. and others less than 0.5 ft. of air, whereas 2 cu. ft. was stipulated. Dense plates gradually choke with sludge, and a mixture of dense and porous plates in a tank results in unequal aeration. "Bacterial growth on plates might require sterilization for their removal."

Fine-woven monel metal cloth has been tried and smaller bubbles issue from the surface of the cloth than from the filtros plates, although the former is more porous than the latter. There is also less frictional loss than through plates.

Open air jets reduce the pressure required but also reduce the efficiency because the bubbles are too large. An orifice 1/1000 of an inch in diameter under 5 lbs. pressure discharges air bubbles 1/32 inch in diameter. Dust, however, will tend to choke such a small orifice. Sludge enters into open jets and cakes within. This was the difficulty experienced at Salford, England, where open jets are largely used. Mr. Copeland suggests flushing such pipe with water under pressure.

Comparison Between Filtros, Air Jet and Monel Metal Diffusers.

Diffusers.	Period. 1915.	Pressure lbs.	Cub. ft. air per gallon.	% Bacteria removed.	Nitrate formed. p.p.m.	Stability of effluent. hours.
Filtros	June 1	4.3	2.5	91	3.4	78
Air jet	Aug. 12	3.5	2.3	91	2.2	52
Filtros	Nov. 18	4.6	2.1	90	0.3	113
Monel Metal	Dec. 7	3.0	2.1	80	0.2	63

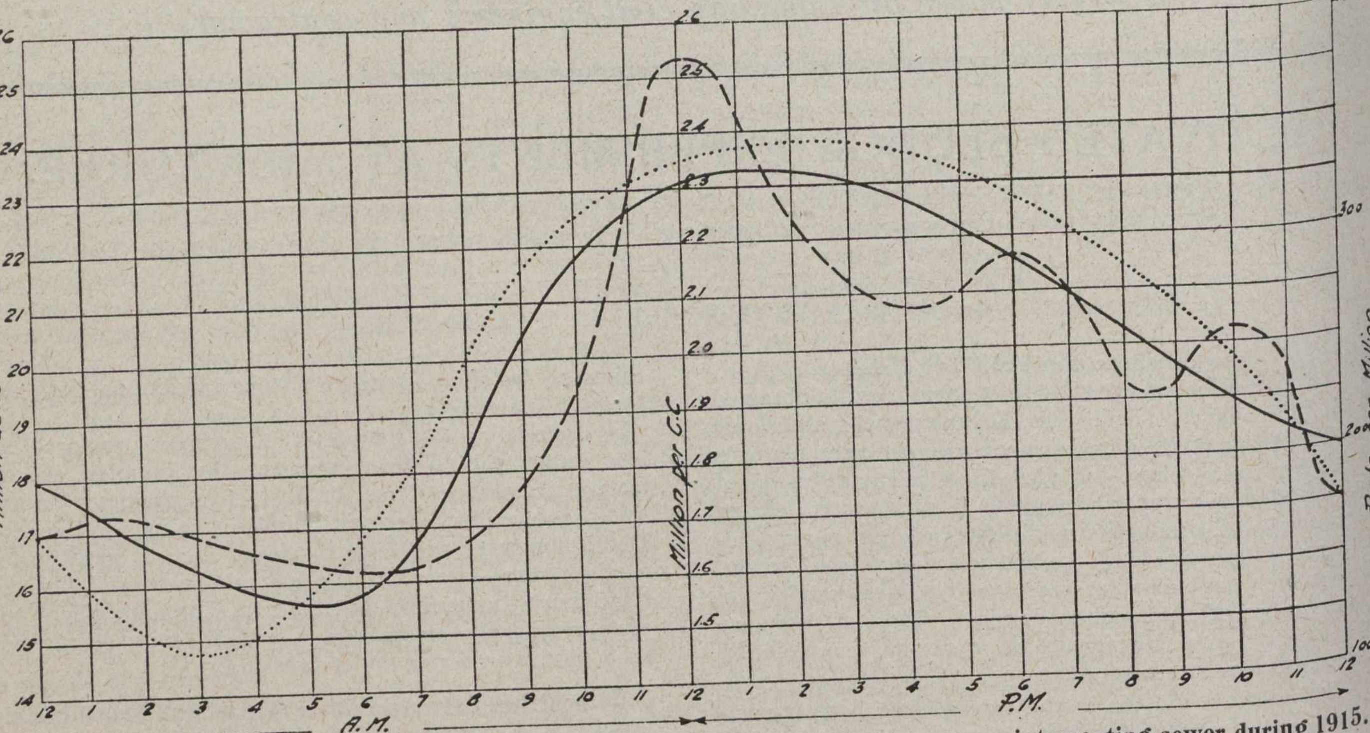
Mr. Copeland states that "open air jets have given good service—almost as good, in fact, as the filtros plate, but they have one bad feature," namely, the sludging up of the orifice. This would indicate that a device similar to one used by the writer might obviate the trouble; that is, to hinge the pipes, and before the air is shut off, swing the pipes out of the tank. Where there are a number of such pipes it requires some ingenuity to arrange the air pipes to avoid complications.

Mr. Copeland mentions a pertinent statement with regard to increasing the depth of tanks so as to prolong the air contact. This matter has also been referred to by Messrs. Ardern and Lockett. The quantity of air per square foot of tank area or per acre will, in a given time, purify more sewage or purify a given quantity to a greater extent in deep tanks than in shallow ones. But deep tanks will require greater pressure and the supply of air will cost more. Whether the advantage will remain with the deep water tanks is not yet proven.

"Our supplementary experiments," according to Messrs. Chalkley Hatton and Copeland, "indicate that more efficiency of air can be obtained in deeper tanks (than 8 to 10 ft.) by reason of the longer contact period between air and sewage, and the tendency of the air, as it escapes from the diffuser, to break into smaller bubbles, because the pressure head is increased. Local conditions might, and probably would, largely control the depth of tank."

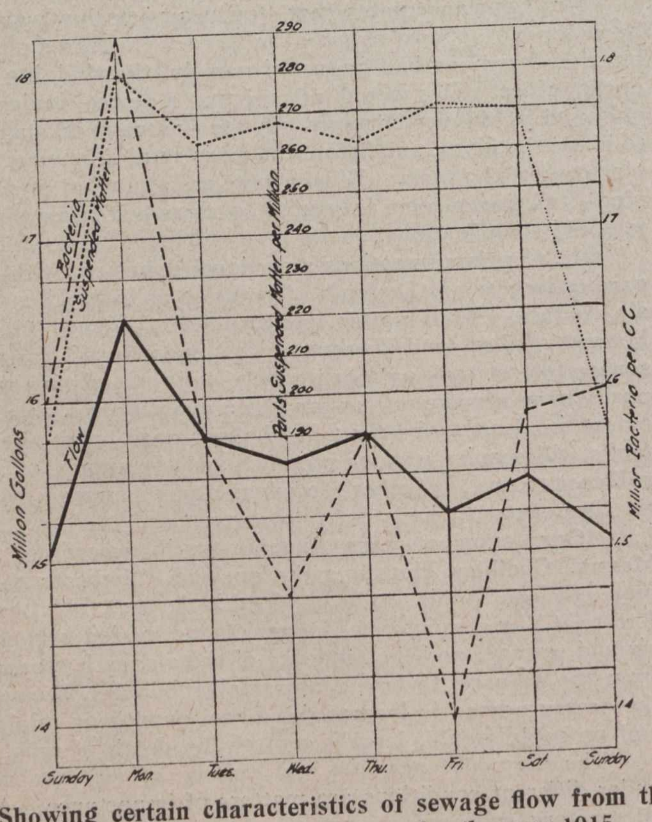
The period of aeration and volume of air required under different conditions are matters of importance. As all sanitary engineers know, the flow and strength of sewage changes throughout the day. The following diagram, taken from the report, will illustrate the average hourly fluctuations of sewage flow at one of the outlets at Milwaukee, as well as varying proportions of suspended matter and bacteria.

According to the diagram, the flow of sewage was lowest at about 5.0 a.m., when it was 80 per cent. of the daily mean, and the greatest flow was at 1.0 p.m., when it was 118 per cent. of the daily mean. The flow from midnight to 8.0 a.m. was 30 per cent. of the mean, so



Showing average hourly discharge of sewage over 20-foot weir from the Menomonee intercepting sewer during 1915. Average flow represented by solid line. Average suspended matter represented by dotted line. Average bacteria per c.c. represented by dashed line.

The next diagram shows the average daily characteristics of the sewage during the year.



Showing certain characteristics of sewage flow from the Menomonee intercepting sewer for the year 1915.

that 30 per cent. was discharged in 9 hours and 70 per cent. in 15 hours.

The following table affords excellent examples of the fluctuating flow and composition of sewage during different periods of the day:—

Volume of Flow and Composition of Sewage During Different Periods of the Day.

Date 1915 Period	No. of Gallons of Sewage	Settleable Solids Cu. Yards per Mil. Gals.	Parts Per Million: Suspended Matter	Oxygen Consumed	Organic Nitrogen	Free Ammonia
April 1st—						
24 hours	12,300,000	17.5	226	159	37	18.2
12-7 a.m.	3,217,000	2.0	70	89	26	14.6
8 a.m.-3 p.m.	5,343,000	32.0	280	193	58	21.2
4-11 p.m.	3,740,000	18.0	240	183	38	15.2
April 29th—						
24 hours	13,070,000	19.0	293	174	52	17.2
12-7 a.m.	3,430,000	4.5	117	70	21	14.7
8 a.m.-3 p.m.	4,960,000	22.0	791	264	92	25.2
4-11 p.m.	4,680,000	13.0	254	156	40	15.2

From the data given in this table it is plain that the disposal plant will have to handle a volume between the hours of 8 a.m. and 4 p.m. that is 30 to 40 per cent. greater than between the hours of midnight and 8 a.m.; and that liquor will in addition be from twice to three times as strong. In short, the plant will have to provide an increase of 100 per cent. in the capacity for purification to meet the overload from 9 a.m. to 4 p.m.

Whereas the volume of sewage will increase, the tank capacity will remain the same; therefore the rate of flow through the plant will increase. If the rate of aeration is kept constant the increasing sewage flow will meet a decreasing proportion of air. Such procedure might overload the activated sludge with organic matter. In our new plant arrangements have been made to store such sludge in tanks with continuous aeration during the period of weak night flow for the purpose of oxidizing the undigested materials. This purified sludge will then be in extra good condition to attack the strong sewage of mid-day.

Mr. Copeland compares the results obtained on Sundays and Mondays and the table below gives the average of four such comparisons.

Relative Purification of Weak and Strong Sewage by Activated Sludge (Fill and Draw.)

Analysis of Treated Sewage.

	Average Number of			Parts Per Million		Nitrogen as		Data Regarding Effluent	
Day of Collection	Gallons Treated	Cu. Ft. of Air Per Gal.	Mil. of Bacteria per c. c. 20° c.	Suspended Matter	Oxygen Consumed	Organic Nitrogen	Free Ammonia	Stability in Hours	Nitrates P.P.M.
Sunday . . .	74,190	2.03	3.11	136	68	27	14.9	..	..
% Removed	..	..	96	99	71	65	60	..	..
Monday. . . .	74,100	2.26	3.37	343	111	28	13.9	120	5.9
% Removed	..	..	96	96	83	75	64	..	..

"Estimating the comparative strengths of these sewages by the amount of suspended matter contained, we see that the Monday sewage was about twice as strong as the Sunday sewage. By increasing the air from 2.03 to 2.26 cu. ft. per U.S. gallon, or 10 per cent., the stronger sewage was treated satisfactorily." On one Monday the suspended matter was six times as much as on the preceding Sunday, and yet 1.8 cu. ft. of air per gallon took care of this strong sewage as 1.9 cu. ft. per gallon took care of the Sunday liquor. Liquor containing as much as 600 parts of suspended matter per million have been successfully treated with less than 2 cu. ft. of air per U.S. gallon. Assuming the quantity of air at 2 cu. ft. per U.S. gallon, which is equal to 2.4 cu. ft. per Imperial gallon, and basing a calculation on four hours' aeration,

$$\text{then, } \frac{22{,}200 \text{ gallons} \times 2 \text{ cu. ft.}}{4 \text{ hours} \times 336 \text{ sq. ft.}} = 33 \text{ cu. ft. per square}$$

foot of tank area per hour, which seems high compared with the results obtained by Messrs. Ardern and Lockett and Dr. Edward Bartow.

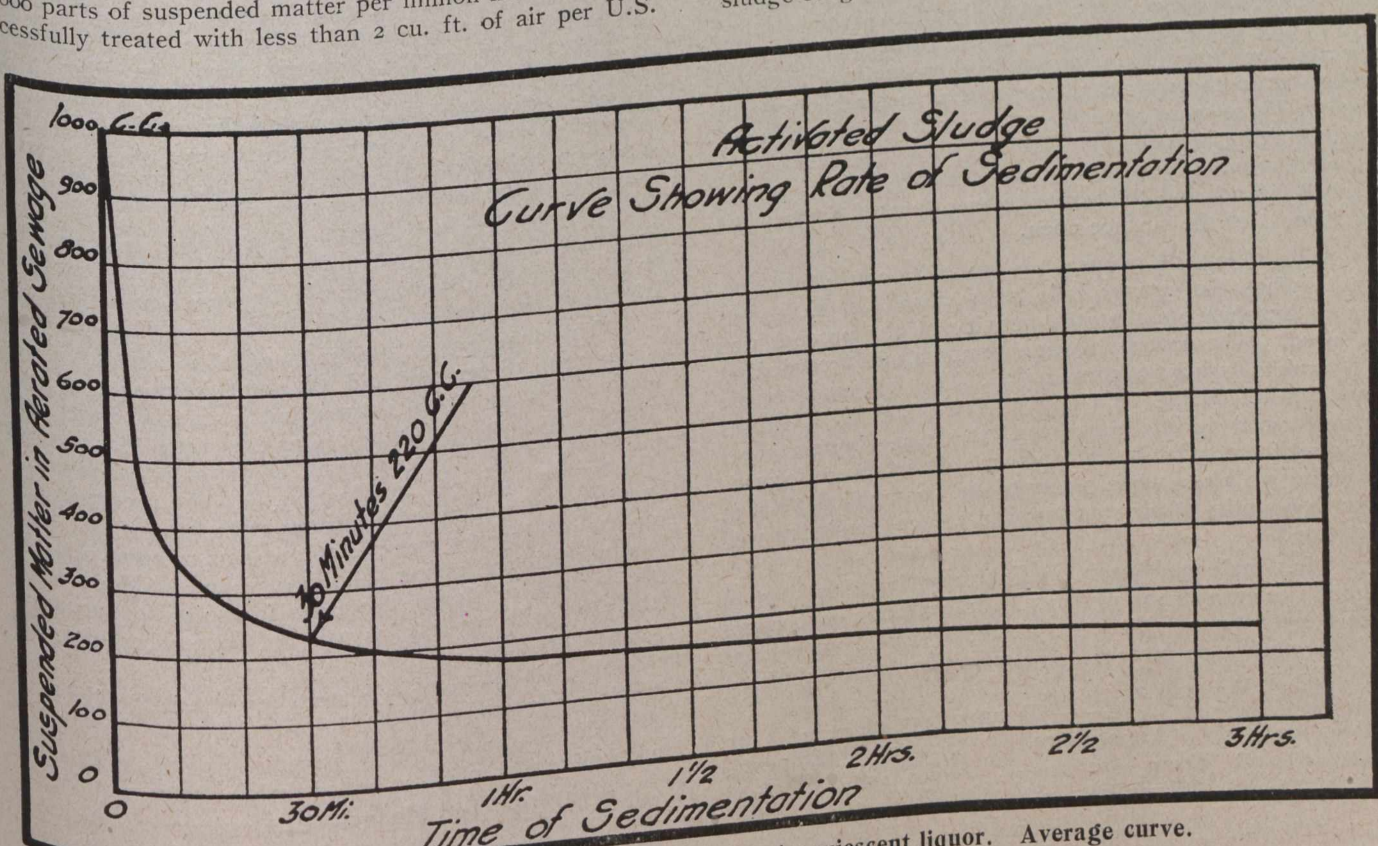
Mr. Copeland supplies a table showing the progressive steps of aeration.

Purification of Sewage Obtained Compared with Period of Aeration.

Period of aeration, in hours	0	1	2	3	4	5
No. of cu. ft. of air per min. . .	0	160	160	160	160	160
Cu. ft. of air per gallon	0	0.66	1.33	1.99	2.66	3.22
*Appearance of settled liquor.	Turbid.	Clear.	Clear.	Clear.	Clear.	Clear.
Stability in hrs. .	0	2	33	120+	120+	120+
% bacteria removed	0	52	81	92+	95+	98+
Parts per million:						
Free ammonia.	22	17	15	11	7	5
Nitrite	0.08	0.00	0.95	1.75	2.20	2.50
Nitrate	0.08	0.04	0.70	2.80	5.60	8.20
Dissolved oxygen	0.00	0.30	1.90	4.30	5.90	6.70
Cost per million gallons.		$1.40	$2.82	$4.25	$5.64	$8.10

*NOTE:—The suspended matter carried by the sewage on this date ran 235 parts per million and the supernatant liquor after 1 hour aeration contained not more than 10 parts per million.

These data point clearly to the fact that well activated sludge coagulated the colloidal matter about as completely



Showing rate of settlement of activated sludge in quiescent liquor. Average curve.

in one hour as it did in five; by three hours it had removed over 92 per cent. of the bacteria from the supernatant liquor and made it stable for a period of more than 5 days.

The sludge was in good condition when this test was made, and the air was applied in such a large volume that by the end of the 5-hour run 3.2 cu. ft. had been added per gallon of sewage treated.

One of the interesting things to note about this table is that so far as clarification was concerned, we got as good efficiency for $1.40 as we did for $8.10; and as good stability for $4.25 as for $8.10. While the bacterial removal obtained for $4.25 was quite sufficient for any ordinary sewage disposal plant.

As purification of sewage by aeration bears a close relation to the volume of air applied, it is instructive to study the following table:—

Relation Between Volume of Air Applied and Purification Obtained by the Continuous Flow Process.

Average Number of				Parts Per Million — Nitrogen as			
Cubic Feet of Air Applied Per Gallon	Gallons Treated Per Day	Stability in Hours	% of Bacteria Removed	Free Ammonia	Nitrate	Organic Nitrogen	Suspended Matter
1.81	62,000	120	98	1.95	8.5	4	11
1.53	65,000	120	99	5.79	9.0	8	9
1.12	65,000	73	91	10.10	2.3	14	42

During the periods covered by the preceding table the liquor required about 5 hours to pass through the tank. The data show that air applied for five hours at a rate of 1.53 cu. ft. per gallon purified the sewage well, but when applied at a rate of only 1.1 ft. the stability obtained was not satisfactory.

The raw sewage often contained H_2S and other foul elements, but by introducing this liquor a few feet below the surface of tank No. 2 these smells were all absorbed.

In fact, the continuous flow process may be described as being odorless, free from the flies which infest sprinkling filters, and capable of destroying the dyestuffs carried by sewage. Fats and other floating materials collected on the surface of the settling basin back of the weir. These were removed occasionally to prevent them from making a thick cake. During very cold weather ice formed around the edges of the tank, but the agitation caused by air and the warm temperature of the sewage kept most of the surface open.

The effects of temperature must be considered, because when the sewage falls below about 60° F. it was found by chemists that the activity of the process was reduced. The lowest sewage temperature recorded at Milwaukee during 1915 was 49° F. The minimum sewage temperature during 1914-15 winter was 44° F. Nitrates were formed during May, 1915, at sewage temperatures ranging from 49° to 54° F. and several parts were formed, even in two hours when plenty of air was applied. Large excess quantity of air was supplied to get the sludge well activated.

Mr. Chalkley Hatton, in February last, was good enough to furnish the writer with information concerning the temperature of the atmosphere, sewage, and effluent at Milwaukee on certain dates which are now tabulated as follows:—

	Temperature of		
Date (1916).	Atmosphere.	Sewage.	Effluent.
Jan. 13 to 18	From —10° to +4° (Average —3°)	Aver. 49°	Aver. 48°
Jan. 21 to 23	Average +32°	Aver. 43°	Aver. 44°

He found that during the cold weather the temperatures had an appreciable influence upon the process; although nitrates were absent, bacteria were reduced 90 to 98 per cent.; suspended matters, 96 to 98 per cent., and the stability ranged from 44 to 120 hours, averaging 118 hours. The two-million-gallon plant, however, was started only a short while before the cold weather set in and it is possible that in an established process the effect of low temperature on the formation of nitrates would be less pronounced.

The temperature of sewage in certain cities is practically always below 60° F. In one place the average ranged from 38° F. in January to 60° F. in August, and after passing through the settling tanks there was an average loss of about one degree and in the percolating filters another 2 to 3 degrees.

Messrs. Ardern and Lockett stated in May, 1914, that with temperatures constantly below 50° F. nitrification was practically inhibited within a period of nine hours' aeration and that the effect would be cumulative over a prolonged period of working, with the probable eventual production of inactive sludge.

At first the writer anticipated difficulties would occur in winter seasons, but the problem is not so serious when the relative specific heats of air and sewage are considered. This matter is full of interest to those concerned in the treatment of sewage by this process.

The production of sludge is of course necessary, and it "must be activated; that is, it must be alive with the aerobic nitrifying bacteria which play the most important part in the process. In other words, the nitrogen cycle must be established and this cycle must be maintained." By the nitrogen cycle is meant the conversion of the ammonia into nitrite and then into nitrate.

Activated sludge may be built up from several sources. Where the sludge retained in a final sedimentation tank from percolating filters, is available it is one of the best seeds for starting activated sludge, because it is already activated with aerobic bacteria from the filters. An anaerobic sludge from Imhoff tanks can be turned into an aerobic activated sludge by using sufficient air during long periods; or the sludge present in the raw sewage can be built up to activated sludge by using sufficient air and sewage on the fill and draw principle.

The efficient activation of sludge was indicated "by the fact that the settled liquor was clear, free ammonia had practically disappeared and the sludge contained more than two parts per million of nitrates."

The quantity of sludge retained in a tank ranging from 30 to 18 per cent. did not affect the degree of purification to any marked degree, but in another part of the report Mr. Copeland states: Our data show that a volume of sludge equal to 20 per cent. of the cubical contents of the tank gives good purification. In the presence of 25 per cent. of sludge more nitrates were formed but the increase in efficiency was not so great as to point clearly to the necessity of having the larger volume. Moreover, as the volume of sludge decreases the room for sewage in the tank will increase, as well as the number of gallons treated per acre."

As this review has already exceeded the limits intended the writer will not discuss this point further.

The diagram on the preceding page indicates the average rate at which activated sludge settles in still water.

Dehydration of Sludge.—It is estimated that at Milwaukee about 15 cu. yds. of sludge per million gallons will be obtained. Activated sludge is very flocculent and contains 98 per cent. of water. When dried to 10 per cent.

moisture the weight will then be about one-half ton per million U.S. gallons. Dehydration by pressing, centrifuging, heating, gravity, etc., have been either tried or considered. Early in our activated sludge process we realized that there was sufficient value in the sludge in the form of unsaponifiable grease and ammonia nitrogen to warrant its being dehydrated, degreased and dried for fertilizer base. Several samples were sent to fertilizer producers in Chicago who reduced them and reported their worth to be from $10 to $20 per dry ton, with plenty of market for all we could produce.

The sludge produced by the process has the general appearance of finely divided sponge, brown in color, and seems to absorb the colloidal matter very rapidly. Highly colored liquor introduced into activated sludge will be decolored in a few minutes.

It drains out upon the ordinary sludge-drying beds in less than one-half the time of the Imhoff tank sludge, but this dewatering is accomplished differently; the first liquor removed from the sludge passes downward through the bed, upon the surface of which the sludge settles, whereupon the remaining liquor rises on the top of the sludge and must be drawn off. The sludge has no apparent odor.

Its moisture content can be reduced from 98 per cent. to 94 per cent. by pressure due to a 26-foot head of water and its volume decreased 40 per cent.

An interesting feature of the process is the inoculation of the sewage by activated sludge. Mr. Copeland states that "in order to purify sewage to best advantage, activated sludge must be fed to the raw sewage as it enters the tank," and to do this he considers that the sludge should be concentrated by hydrostatic pressure. It is known that sludge from a two-story tank contains less water as the depth at which it is digested increases. Four hours' storage in a 3-in. pipe 26 ft. high at Milwaukee resulted in the moisture being reduced from 98 to 94 per cent., so that 100 units were reduced to $100 \times \frac{100-98}{100-94} = \frac{2}{6} = 33.33$. The sludge was raised by an air-lift pump. No information is given as to the proportion returned to the sewage inlet. The report, however, states that "there is no necessity of returning more than enough sludge to keep the tank charged with its proper proportion, but in order to secure the proper proportion it was necessary with the apparatus at hand, to return a large excess of treated liquor with the sludge." To return more than this volume forces liquor through the tank at an unnecessarily high rate, with the result that the sewage will get insufficient treatment. On the other hand, if the sludge is not pumped out of the settling basins fast enough it will fill them up and run out of the overflow. In order to avoid these difficulties the discharge from the sludge lift should be run into sludge treatment tanks. Most of the sludge will flow as freely as water, and on the same slope, but the heavier masses of sludge consisting of waste, paper, etc., do not flow readily and therefore the sides of the pipes or troughs must be smooth.

The term "proper proportion" may perhaps be interpreted as the percentage of the tank capacity occupied by sludge, say, 25 per cent. settleable in 30 minutes. Attention has already been drawn to the plan of storing and aerating sludge during the hours of weak night flow, so that it will be in good condition to attack the strong sewage of mid-day.

Despite the fact that there is yet much to learn—and what process is there which has reached its perfect stage of finality?—the activated sludge system of sewage treatment has been established as one which will produce better results than any other known method, excepting possibly land irrigation under exceptional conditions.

Municipal engineers owe much to Messrs. Chalkley Hatton and Copeland for conducting experiments on a large scale to prove the practicability of the process evolved by Messrs. Ardern and Lockett under different conditions.

The writer acknowledges his indebtedness to the above gentlemen and to Mr. John H. Fowler for information bearing upon the important subject under review.

LETTER TO THE EDITOR.

Revision of the Patent Act.

Sir,—Your issue of May 11th contains a letter with suggestions as to the amendment of the Patent Act and improvements in patent practice, made by Mr. W. S. Babcock, of Montreal. With some, at least, of these suggestions we are heartily in accord. The patent and the trade mark branches of the Patent Office will never get sufficient attention as long as they are merely adjuncts of the Department of Agriculture, the head of which is usually someone whose interests and experience are largely agricultural.

The suggestion that patentees be given the option of having their patents subjected to compulsory manufacture or compulsory license, is a good one. The manufacturing section of the act in the past has been more of a nuisance to patentees than of benefit to manufacturers. It may also be advisable to have interferences decided by an official of the patent office, as the proper weighing of the various points which require to be considered in an interference case necessitates special experience, not only in the consideration of evidence, but in the consideration of the various points of the invention in issue. The average arbitrator appointed by the government often falls woefully short in the latter feature. We have not noticed, however, that the interference proceedings in the United States office are very much cheaper than the decision of a Canadian interference by arbitration.

As to the substitution of a continuous term of eighteen years, with a somewhat increased first payment, in place of the present renewal system, there may be differences of opinion. It is often of considerable advantage to get rid of the patents which are allowed to expire at the end of the first six years of their life. It greatly reduces the number of patents that have to be kept in mind when determining the question of infringement. It is quite possible that the provision of extensions of time for payment of renewal fees on the payment of certain fines would meet the requirements.

Our suggestion would be that the government appoint a commission including representatives of the patent office, patent attorneys, lawyers, inventors, and manufacturers, to consider the whole situation and to make recommendations for revision of the Act, improvement in the organization of the patent office, and improvements in patent procedure.

RIDOUT & MAYBEE,
Solicitors of Patents, Toronto.
Per J. Edward Maybee.

Toronto, May 15th, 1916.

RULES FOR CONDUCTING PERFORMANCE TESTS OF POWER PLANT APPARATUS.

IN 1909 a Power-test Committee was appointed by the American Society of Mechanical Engineers to "revise the present testing codes of the Society relating to boilers, pumping engines, locomotives, steam engines in general, internal combustion engines, and apparatus and fuels therefor, and to extend these codes so as to apply to such power generating apparatus as the present codes do not cover, including water-power, bringing them into harmony with each other and with the best practice of the day." This committee has just recently turned in its report, and among other things suggest the following rules for conducting tests of waterwheels, steam turbines and turbo-generators. These being of considerable interest to our readers, we are pleased to reprint them.

Rules for Conducting Tests of Waterwheels.

Introduction.—Waterwheel tests may be divided into two classes, one of which may be termed "shop" tests and the other "field" tests. The former refer to those which are conducted in a plant devoted exclusively to testing work, and the latter to tests of the wheel in its permanent location. The Holyoke Water Power Company's testing flume is an example of a shop-testing plant, being one which is equipped for turbine waterwheels of any size up to 300 h.p. at 18-ft. head. This plant, it is understood, is also at present the only one of the kind in the country which is available for commercial work. Under these circumstances there seems to be no call at the present time (1915) for a general code of rules applying to tests of that character. The tests to which the following code refers are, therefore, limited to field tests, the wheel being in place, and operating, so far as possible, under the conditions of service for which it was installed.

Object and Preparations.—The usual object of a waterwheel test in the field is the determination of the capacity and efficiency of the wheel at various gate openings, and, if practicable, at vaious speeds, as compared with standard or guaranteed performance. Having determined the object, whatever it may be, take the dimensions, note the physical condition of the wheel and of the plant throughout, install the testing appliances, etc., following the general instructions given in ¶ 1 to 20, so far as they pertain to the work in hand, and make preparations for the test accordingly.

The most important preparations are those which relate to the determination of the power developed by the wheel, and the quantity of water which it consumes. The nature of these preparations is governed altogether by the character of the equipment. As regards power determination, the simplest method is the one applying to a case where the wheel drives an electric generator and the power is measured by calculation from the electrical output. Another simple method is one which may be used where the wheel serves as an auxiliary to steam power, and the load is reasonably constant, in which case the output is determined by ascertaining the difference between the indicated horse-power developed by the engine when the wheel is on and that developed when the wheel is off. Another method which is applicable to almost any situation where there is room, although the most difficult of the three, is the use of a friction brake attached to the waterwheel shaft, being arranged so as to take the place of a section of the shaft which may temporarily be removed. As to preparation for water measurement, the desirability of preserving the maximum head of water usually makes it necessary to gauge the stream supplied to the wheel or the stream leaving it, and to select or prepare for this purpose a sufficient length of canal having a uniform cross-section to determine the required velocity by float measurement. Another method consists in the use of current meters or pitometers which have been properly calibrated. In cases where some part of the head may be sacrificed either in the head race or tail race, the measurement may be made by the insertion of a suitable weir.

Apparatus and Instruments.—The apparatus and instruments required for a capacity and efficiency test of a waterwheel are:—

(*a*) A friction brake, steam engine indicators, or electrical instruments, depending on the character of the equipment.
(*b*) Graduated scales showing the heights of water in the flume above the wheel and in the discharge pit beneath.
(*c*) One or more current meters or other apparatus for ascertaining the velocity of the water; or a weir.

Directions for the use of these appliances may be found in ¶ 9 and in Appendices Nos. 18, 19, 21, and 5.

It is of the greatest importance that the water measured is that which is consumed wholly by the wheel. If water leaks by without going through the wheel, the quantity of leakage should be determined by independent measurement when the wheel is entirely shut off, in which case the gross quantity is corrected accordingly.

Duration.—The duration of a simple efficiency test of a waterwheel depends mainly upon the method of water measurement employed, and the time required to obtain a sufficient number of observations to insure a reliable average. After the desired load and other conditions have been obtained, continuous observations and measurements for a period of 15 minutes is sufficient for all practical purposes, provided the water is measured by a weir, but a longer time is necessary when other methods of measurement are used.

Records.—The records should be obtained in a manner conforming to the principles explained in ¶ 15 to 18. Readings of the weight on the brake-arm, levels of water in the flume and discharge-pit, indications of the current meters, and revolutions per minute, should be taken every five minutes, and at more frequent intervals if they show much fluctuation. In case of float measurement, repeated observations should be made one after the other throughout the whole period of the trial.

Calculation of Results.—The total average head of water on the wheel is obtained by adding together the reading of the scale in the flume and the vertical distance between the zero of this scale and that of the scale in the discharge-pit, and subtracting the reading of the latter scale, both readings being taken in reasonably still water. The velocity of water in the measuring canal is found by averaging the readings obtained at several points extending over the whole width of the canal. The cubic feet of water flowing per second is obtained by multiplying the cross-section of the stream in square feet by the velocity of the water in feet per second, determined as stated above. The total power of water available is obtained by multiplying the net weight of water in pounds discharged per second by the total average head in feet on the wheel, and dividing the product by 550. The brake horse-power developed by the wheel is found by multiplying the net weight on the brake-arm in pounds by the circumference of the corresponding circle in feet and by the number of revolutions per minute, and dividing the final product by 33,000.

In the case of a wheel supplied through a penstock the head is found by adding together the pressure at the intake to the wheel case, the velocity head at this point, and the elevation of the point above the surface of the tail water, all expressed in feet.

In an impulse wheel, the head is the sum of the pressure at the nozzle, in feet and the velocity head at that point in feet.

Data and Results.—The data and results should be reported in accordance with the form given herewith (Table 21), adding lines for data not provided for or omitting those not required, as may conform with the object in view:—.

Table 21.—Data and Results of Waterwheel Test Adapted to Brake Measurement of Power.

Code of 1915.

(1) Test of............water wheel located at..............
To determine ....
Test conducted by......................................
(2) Type of wheel and class of service......................
(3) Type of generator, if any, kind of current, etc..........
(4) Rated power of wheel............................h.p.
(5) Cross-section of stream where velocity of water is measured ....sq. ft.

GENERAL DATA.

(6) Date ....
(7) Duration of period covered by test..................hr.
(8) Average net weight on brake arm....................lb.
(9) Average revolutions per minute..................r.p.m.
(10) Total average head of water on wheel................ft.
(11) Average velocity of water per second in measuring canal ....ft.
(12) Volume of water flowing per second................cu. ft.
(13) Weight of water flowing per second (Item 12 × 62.35) ....lb.
(14) Leakage per second...................................lb.
(15) Net water discharged by wheel per second (Item 13 — Item 14)..lb.

POWER.

(16) Total power of water available.....................h.p.
(17) Brake horsepower developed by wheel...........br. h.p.

EFFICIENCY.

(18) Efficiency of wheel, (Item 17 ÷ Item 16) × 100..per cent.

Rules for Conducting Tests of Steam Turbines and Turbo-Generators.

Introduction.—The code for steam turbine tests applies to tests for determining the performance of the turbine alone, apart from that of steam-driven auxiliaries which are necessary to its operation. For tests of turbine and auxiliaries combined, and tests of turbines from which steam is withdrawn for heating feed water or other purposes, refer to the Code for Complete Steam Power Plants, Part IX. For methods of conducting tests of generators, motors, etc., and for general information bearing on the subject, reference may be made to the Standardization Rules of the A.I.E.E.

Object and Preparations.—Determine the object of the test, take the dimensions and note the physical conditions not only of the turbine, but of the entire plant concerned, examine for leakages, install the testing appliances, etc., as pointed out in the general instructions given in * ¶ 1 to 33 and prepare for the best accordingly (as given in the pamphlet report covering this subject).

Apparatus and Instruments.—The apparatus and instruments required for a performance test of a steam turbine or turbo-generator are:—

(*a*) Tanks and platform scales for weighing water, (or water meters calibrated in place).
(*b*) Graduated scales attached to the water glasses of the boilers.
(*c*) Pressure gages, vacuum gages, and thermometers.
(*d*) Steam calorimeter.
(*e*) Barometer.
(*f*) Tachometer, revolution-counter, or other speed-measuring apparatus.
(*g*) Friction brake or dynamometer.
(*h*) Volt meters, ammeters, wattmeters, and watt-hour meters for the electrical measurements in the case of a turbo-generator.

*Directions regarding the use and calibration of these particular appliances are given in ¶ 7 to 9, and in ¶ 24 to 33.

The determination of the heat and steam consumption of a turbine or turbo-generator should conform to the same methods as those described in the Steam Engine Code, Part V.

If the steam consumption is determined from the water discharged by the wet vacuum or hot-well pump, correction should be made for water drawn in through the packing glands of the turbine shaft, for condenser leakage, and for any other foreign supply of water.

Operating Conditions.
Duration.
Starting and Stopping.
Records.
Calculation of Results.

The rules pertaining to the subjects, Operating Conditions, Duration, Starting and Stopping, Records, and Calculation of Results, are identically the same as those given under the respective headings in the Steam Engine Code, ¶ 71 to 77, with the single exception of the matter relating to indicator diagrams and results computed therefrom; and reference may be made to that code for the directions required in these particulars.

Data and Results.—The data and results should be reported in accordance with the form (Table 11) given herewith, adding lines for data not provided for, or omitting those not required, as may conform to the object in view. If a shorter form of report is desired, the items in fine print designated by letters of the alphabet, may be omitted; or if only the principal data and results are desired, the subjoined abbreviated table (Table 12) may be used. Unless otherwise indicated, the items should be the averages of the data.

Table 11.—Data and Results of Steam Turbine or Turbo-Generator Test.

Code of 1915.

(1) Test of...............turbine located at...............
To determine..
Test conducted by.....................................

DIMENSIONS, ETC.

(2) Type of turbine (impulse, reaction, or combination)....
(*a*) Number of stages..................................
(*b*) Condensing or non-condensing.......................
(*c*) Diameter of rotors.................................
(*d*) Number and type of nozzles.........................
(*e*) Area of nozzles....................................
(*f*) Type of governor...................................
(3) Class of service (electric, pumping, compressor, etc.)...

(4) Auxiliaries (steam or electric driven)....................
 (a) Type and make of condensing equipment.......
 (b) Rated capacity of condensing equipment.......
 (c) Type of oil pumps (direct or independently driven)....................................
 (d) Type of exciter (direct or independently driven)..
 (e) Type of ventilating fan, if separately driven....

(5) Rated capacity of turbine..........................
 (a) Name of builders..............................

(6) Capacity of generator or other apparatus consuming power of turbine..............................

DATE AND DURATION.

(7) Date ....
(8) Duration ....hr.

AVERAGE PRESSURES AND TEMPERATURES.

(9) Pressure in steam pipe near throttle by gage ....lb. per sq. in.
(10) Barometric pressure.....................in. of mercury
 (a) Pressure at boiler by gage........lb. per sq. in.
 (b) Pressure in steam chest by gage....lb. per sq. in.
 (c) Pressure in various stages.........lb. per sq. in.

(11) Pressure in exhaust pipe near turbine, by gage ....lb. per sq. in.
(12) Vacuum in condenser...................in. of mercury
 (a) Corresponding absolute pressure..lb. per sq. in.
 (b) Absolute pressure in exhaust chamber of turbine.................lb. per sq. in.

(13) Temperature of steam near throttle...............deg.
 (a) Temperature of saturated steam at throttle pressure ....deg.
 (b) Temperature of steam in various stages, if superheated ....deg.

(14) Temperature of steam in exhaust pipe near turbine..deg.
 (a) Temperature of circulating water entering condenser ....deg.
 (b) Temperature of circulating water leaving condenser ....deg.
 (c) Temperature of air in turbine room........deg.

QUALITY OF STEAM.

(15) Percentage of moisture in steam near throttle, or number of degrees of superheating ....per cent. or deg.

TOTAL QUANTITIES.

(16) Total water fed to boilers..........................lb.
(17) Total condensate from surface condenser (corrected for condenser leakage and leakage of shaft and pump glands).......................................lb.
(18) Total dry steam consumed (Item 16 or 17 less moisture in steam)..................................lb.

HOURLY QUANTITIES.

(19) Total water fed to boilers or drawn from surface condenser per hour.............................lb.
(20) Total dry steam consumed for all purposes per hour (Item 18 ÷ Item 8)...................................lb.
(21) Steam consumed per hour for all purposes foreign to the turbine (including drips and leakage of plant) ....lb.
(22) Dry steam consumed by turbine per hour (Item 20 — Item 21) ....lb.
 (a) Circulating water supplied to condenser per hour ....lb.

HOURLY HEAT DATA.

(23) Heat units consumed by turbine per hour [Item 22 × (total heat of steam per pound at pressure of Item 9 less heat in 1 lb. of water at temperature of Item 14)]..................................B.t.u.
 (a) Heat converted into work per hour........B.t.u.
 (b) Heat rejected to condenser per hour (Item 22a × [Item 14b—Item 14a]) (approximate) ....B.t.u.
 (c) Heat rejected in the form of steam withdrawn from the turbine..................B.t.u.
 (d) Heat lost by radiation from turbine, and unaccounted for ....B.t.u.

ELECTRICAL DATA.

(24) Average volts, each phase..........................volts
(25) Average amperes, each phase..................amperes
(26) Average kilowatts, first meter........................kw.
(27) Average kilowatts, second meter......................kw.
(28) Total kilowatts output...............................kw.
(29) Power factor ....
(30) Kilowatts used for excitation, and for separately driven ventilating fan...........................kw.
(31) Net kilowatt output..................................kw.

SPEED.

(32) Revolutions per minute............................r.p.m.
(33) Variation of speed between no load and full load ....r.p.m.
(34) Momentary fluctuation of speed on suddenly changing from full load to half-load.............r.p.m.

POWER.

(35) Brake horsepower, if determined.................br. h.p.
(36) Electrical horsepower ....e.h.p.

ECONOMY RESULTS.

(37) Dry steam consumed by turbine per br. h.p.-hr.......lb.
(38) Dry steam consumed per net kw-hr....................lb.
(39) Heat units consumed by turbine per br. h.p.-hr. (Item 23 ÷ Item 35) ....B.t.u.
(40) Heat units consumed per net kw-hr..................B.t.u.

EFFICIENCY RESULTS.

(41) Thermal efficiency of turbine (2546.5 ÷ Item 39) × 100 ....per cent.
(42) Efficiency of Rankine cycle between temperatures of Items 13 and 14.......................per cent.
(43) Rankine cycle ratio (Item 41 ÷ Item 42)..................

WORK DONE PER HEAT UNIT.

(44) Net work per B.t.u. consumed by turbine (1,980,000 ÷ Item 39) ....Ft.-lb.

Table 12.—Principal Data and Results of Turbine Test.

(1) Dimensions ....
(2) Date ....
(3) Duration ....hr.
(4) Pressure in steam pipe near throttle by gage ....lb. per sq. in.
(5) Vacuum in condenser ....in. of mercury
(6) Percentage of moisture in steam near throttle or number of degrees of superheating ....per cent. or deg.
(7) Net steam consumed per hour.........................lb.
(8) Revolutions per minute............................r.p.m.
(9) Brake horsepower developed.......................br.h.p.
(10) Kw. output ....kw.
(11) Steam consumed per brake h.p.-hr....................lb.
(12) Heat consumed per brake h.p.-hr..................B.t.u.
(13) Steam consumed per kw-hr...........................lb.
(14) Heat consumed per kw-hr...........................B.t.u.

The MacArthur Concrete Pile and Foundation Co., of New York, have announced the removal of their office to the Equitable Building, 120 Broadway, New York.

Fred. L. Macpherson, municipal engineer, of Burnaby, B.C., laid 1,500 sq. yds. of waterbound macadam, scarified and oiled 15,000 sq. yds., and oiled 150,000 sq. yds. of macadam during the year 1915. Total pavements laid to date are 78,000 sq. yds. of asphaltic concrete and 175,000 sq. yds. of waterbound macadam. During 1916 it is planned to lay 6,000 sq. yds. of waterbound macadam and to do about the same amount of scarifying and oiling as was done last year.

WIDTH AND ALLOCATION OF SPACE IN ROADS.*

By F. Longstreth Thompson, B.Sc., Assoc.M.Inst.C.E.

IN approaching the subject of "the width and allocation of space in roads" one is at once struck by the impracticability of attempting too much in the way of standardization. There is such a large diversity, for instance, in what may be termed the "quality" of traffic, that two roads carrying the same number of vehicles may require quite different widths. As an illustration of what I mean, take the heavy and slow moving traffic in a road serving the docks, and compare it with an equal volume of fast moving motor traffic on an ordinary road; the latter will only require about a third of the width necessary for the former.

Collection of Statistics.—It will be appreciated, therefore, at the outset that a careful classification of roads is needed, having as the chief consideration the prevailing type of traffic, and secondly, the volume of such traffic. A great deal of preliminary investigation is required in order to obtain accurate statistics for both the classification and subsequent design.

A certain amount of work of this kind has been done in more or less isolated cases up and down the country, and the investigations of the London Traffic Branch of the Board of Trade made for some of the principal London streets afford a valuable example of the method in which these inquiries should be conducted.

Observations were made on weekdays in both summer and winter, which showed that while there was considerably more passenger traffic in summer, the commercial traffic remained fairly steady throughout the year.

The fluctuations in volume during the day were, of course, very marked in and near the city, where the full stream of the morning influx and the evening exodus was felt, and the maximum volume was found to be on the whole about twice the average. Provision should be made in consequence for the maximum traffic.

The distinguishing between through and local traffic was found to be difficult of accomplishment, but this information is of the greatest importance, and some means of obtaining it must be found.

The mere number of vehicles passing does not afford sufficient data, and a scale of values was adopted, based on the amount of obstruction caused by the various types of vehicles, having regard to their size, speed and flexibility.

It is essential to assign values to the various classes of vehicle, for it is obvious that a heavy and slow moving goods lorry is a far greater obstruction, owing to its slowness and lack of flexibility, than, for instance, a taxicab, and the measure of the capacity of a street is therefore not its capacity of providing for such and such a number of vehicles, but for so many units of obstruction.

I have tried so far—very imperfectly, I know—to give a brief outline of the kind of data that it is desirable to collect for the purpose of determining the volume of traffic which has to be dealt with, and before I pass on to the use of this data in designing the road I would like to put in a plea for a systematic traffic census to be taken throughout the country twice a year—summer and winter. In this way we should accumulate statistics which would prove of inestimable value to town planners at a relatively insignificant cost.

*From a paper read at a meeting of the Town Planning Institute, held on March 10th, 1916.

Determination of Width.—While the great complexity of modern traffic—the mixture of fast and slow, cumbrous and flexible, local and through—makes it almost impossible to determine mathematically the utmost carrying capacity of a road, or conversely to calculate the necessary width for a given volume, it is possible from a consideration of—(1) The nature of the district, (2) the class of traffic, (3) the general importance of the traffic, (4) the observed volume of the traffic, to determine from general principles the number of lines of traffic to provide for, and hence the width of road to allow.

Provision must, of course, be made for the future, and it is here that the lack of reliable records handicaps us a good deal.

In our eagerness to avoid the costly mistake of underestimating future needs, we must guard against providing excessive width where it will never be required.

In this connection there is one very important safeguard in the hands of the town planner, which, however, requires careful and discriminating use.

It is possible—and indeed it should be the basis of design—so to plan the streets as regards position, direction, gradient, and width that the character of the street is definitely settled. Traffic streets should always be the widest, most direct, and best graded, and there should be no inducement for traffic to leave them and invade the quiet and seclusion of the residential roads.

The importance of settling the character of the street in this way can hardly be over-estimated.

It has the great advantage of enabling the designer to consecrate his energies on the provision of adequate width where it is certain to be wanted, and it furthermore has the most beneficial effect on the property fronting the various types of street, for where the character of the street is settled there is no risk of it being spoilt for its particular purpose, and its value is therefore assured.

This brings us at once to the need for classifying roads according to their use. They naturally divide themselves into two principal classes—traffic roads and residential roads.

Traffic roads lend themselves to sub-division under numerous headings, but it will be convenient to limit them to main avenues, main streets, secondary streets, local streets, boulevards and parkways.

Main Avenues.—The function of the main avenue is to form the chief artery by means of which traffic from one of the trunk roads of the country enters or leaves the city.

It will be desirable to provide for either a service of motor omnibuses, a surface tramway, or an underground tramway, or possibly some combination of these. My own personal feeling is that the motor omnibus will gradually oust the tramcar from the streets, and that tramways will develop much more on the lines of electric railways, and be located consequently either in a shallow subway under the road or, where space permits, in an open cutting.

Up till now it has been usual to allow at least one double track of tramway on the surface in proposals for main avenues, and the Advisory Board of Engineers to the Royal Commission on London Traffic, 1905, suggested that, in addition to a double track of fast trams in the centre of the road, there should be a line of stopping cars on each side, while they also provide a subway to take double tracks for both fast and slow electric trains. These proposals are perhaps excessive, and I think they might very well be limited to a double track for trains on the surface, and a subway with a double track for electric trains.

The number of lines of ordinary traffic which should be provided is essentially a matter which ought to be decided on the merits of each particular case, but for purposes of comparison I have assumed that the streets considered under each of the headings are those of a large city.

There is a general consensus of opinion that for main avenues lined with shops or business premises four lines of traffic should be provided on each side of a central tramway. This allows for one line to be occupied by vehicles stopping at the curb, one by slow moving vehicles, and two by fast traffic.

Taking each line of traffic at a width of 8 ft., we get a total of 64 ft., to which must be added the tramway and the footpaths.

The width we can afford to allot to the tramway must depend entirely on the special circumstances of the case. Under any conditions, however, I think it desirable that the track should be definitely reserved for trams by means of a raised curb, and the minimum width allowable should be not less than 20 ft. Where it is possible to lay a sleeper track in grass between an avenue of trees it will be necessary to reserve a width of about 40 ft.

The customary allowance for footpaths is one-fifth of the total width on each side, but in the case of very wide roads this is unnecessary, and a width of 20 ft. seems to be a reasonable maximum.

It will be seen that we have a total width of 124 ft. between buildings, and I think we may regard this as a suitable width for a main avenue in a built-up area.

In districts not yet fully developed, where it is possible to secure a greater width without undue expenditure—as, for instance, under the provisions of a town planning scheme, there will be greater opportunities of providing for the amenities, and many variations suggest themselves.

Whatever allocation is adopted, however, I feel convinced that one or two guiding principles should be rigidly adhered to.

In the first place, fast traffic should be located as far as possible from those parts of the road devoted to foot passengers, in order that the noise, dust, and sense of unrest inevitably associated with fast moving vehicles shall disturb pedestrians as little as may be.

In the second place, tramways, whether they are placed towards the sides of the road or in the centre of it, should have a track entirely to themselves. This secures not only much more efficient working of the trams, but it also conduces in a very pronounced way to the safety and comfort of the other traffic.

In the third place, the indiscriminate use of trees and grass is to be guarded against.

If trees are to be used successfully, they must form a definite part of the street picture, either as a foil to the architecture, or for the purpose of affording shade, or protection from noise and dust. Nothing can be more unsatisfactory than trees badly placed, or planted under conditions such as insufficient space or too smoky an atmosphere, where they have not a chance to grow properly and quickly become an eyesore.

Much the same argument applies to turf; if rightly placed, under conditions where it flourishes and is well looked after, it is a continual source of delight, but where these conditions do not obtain it is far better to use gravel.

Main Streets.—These include those streets which, though of first-rate importance, do not fall within the category of main avenues.

It is impossible to lay down hard and fast definitions of the various classes, but perhaps the best description in this case would be those streets which form the main traffic routes within the city itself.

They form a group of hardly less importance than main avenues, and much the same considerations govern their design.

The probabilities are, however, that the available space will be more restricted, though, on the other hand, the traffic to be provided for may be rather less.

Provision for three lines of traffic on each side of a double tramway track will not be by any means excessive, and taking this as a reasonable standard, together with two footpaths each 18 ft. wide, a total width of 104 ft. is arrived at.

We are again confronted with the problem of deciding whether to provide an electric railway under the street, and on the whole I think it would be wise to do so.

In any case, I think we shall all be agreed on the necessity for providing adequate subways for the various mains, which all need attention at frequent intervals, to the great inconvenience of the general public, when, as is usually the case, it necessitates taking up portions of the footpath or carriageway.

An alternative arrangement is where the trams are placed at the side of the road, but this has the grave disadvantage that persons alighting from vehicles drawn up at the curb have to cross the track in order to reach the footpath.

There is no little danger, I think, when one is endeavoring to arrive at some sort of a standard width for any type of road that a nightmare of uniformity may be the result.

This is so far removed from the ideals of a town planner that it is more than ever necessary to urge that the object aimed at is not a standardization of roads, but a standardization of the principles of design.

In this connection we have a very important problem before us. For, whereas there is a fairly general agreement amongst traffic experts that a width of about 100 ft. is a proper allowance for main streets in cities, we have a totally different opinion expressed by men with a large experience of retail trade.

All the gentlemen who kindly let me know their views as to the general requisities of a shopping street agreed that main traffic streets offered the best opportunities for shops. They wish, however, to limit the width—in the interests of shopping—to from 50 to 70 ft.

A compromise might be accomplished by abolishing the surface tramway and replacing it by an underground tramway, probably in conjunction with motor buses. A further economy in width is realized by a strict relegation of all delivery vans to a service road in the rear of the shops, while a footpath 18 ft. in width would allow of frequent bays for the accommodation of vehicles wishing to draw up and deposit passengers.

Secondary Streets.—These may be said to form the connecting links in the system of main streets. They probably will not deal to any extent with through traffic, but are likely to carry a considerable volume of local or semi-local traffic.

A few, acting as supplementary ring roads within the city, will require tramway tracks, but as a general rule it may be taken that these will not be necessary.

In no other class of street perhaps does the width and allocation of space depend so much on the particular needs of the locality, and a large number of variations are possible.

The definition of secondary streets is necessarily more elastic than in the other classes, with the exception of boulevards or parkways, and widths have been proposed varying from 60 ft. to 80 ft.

A width of about 40 ft. will be sufficient for local streets, which provides for two footpaths each 8 ft. wide and carriageway of 24 ft.

Boulevards and Parkways.—In the design of boulevards the town planner has perhaps his greatest opportunity of providing for the city a feature distinctive in character, useful in purpose, and an unbounded source of delight both to the visitor and the thousands of people who daily make it their promenade.

One very important point to be borne in mind in the design of boulevards is that they should connect up and form part of the park system. This consideration will lead to a generous allocation of space to the park-like features, which will undoubtedly result in a much greater use of the parks themselves than is the case when they are separated by tracts of uninviting bricks and mortar.

Residential Roads.—It has been urged in the earlier part of this paper that the provision of wide roads should be limited to the traffic routes, and that these should be made *so good* that there is no inducement for traffic to leave them and invade the privacy of residential roads.

Now, we have ample evidence that this principle has not been followed in the past, and the result has been an unscientific and ugly uniformity, together with an overcrowding of houses upon the land.

The Housing and Town Planning Act, however, comes to our assistance in this respect by giving the local authority power to vary by-laws in the provision of a town planning scheme, and, as is well known, substantial reductions from the by-law width in the case of short streets are actually in force under the Ruislip-Northwood scheme.

With proper safeguards as to the limitation of the number of houses to the acre, the proportion of curtilage which may be occupied by buildings, suitable building lines, and a restriction on the height of the buildings, I think we may look forward to much more reasonable requirements as regards the width of the roads. In addition to the relaxation of the by-law width, however, considerable freedom should be allowed both in the design and construction of residential roads.

There is room for almost every kind of treatment, from the glorified carriage drive to the formal square, and it may be said, I think, with some truth that the only really guiding principle should be to make each road suitable to the property it serves.

One hesitates to make suggestions in regard to a subject where generalizations serve no useful purpose, but a few notes may not be altogether out of place.

In a high-class residential district where there are few houses and large gardens, traffic is reduced to a minimum, and it will be possible to make use of a narrow road possessing something of the characteristics of a carriage drive. One footpath will be ample, and the trees should be planted on the garden side of the hedge.

On roads having a crossfall an economy can be practised and a charming effect produced by keeping the footpath at a higher level than the carriageway.

In the development of smaller class property, including that occupied by the working classes, the houses are necessarily much closer together, and consequently the roads will be busier.

Here much can be done by careful planning, so that one fairly wide road may serve a large area developed by means of smaller roads, drives, closes, and so forth.

These minor roads can quite suitably dispense with a footpath altogether, and examples are in existence at Earswick, Letchworth, and other places, where this has been done with most happy results. Where vehicles use roads of this type a minimum width of 18 ft. should be provided.

As regards the design of formal residential roads, I do not propose to say more than that they should form a definite part of the architectural scheme. The proportion of the width allotted to the footpaths and planted strips will naturally be greater, and that for vehicles less, than is the case for streets of similar dimensions designed for traffic.

BUILDING A DEEP-WATER CONCRETE PIER ON SHORE AT VICTORIA, B.C.

THE development now in progress of the Victoria, B.C., harbor involves the construction of about 5,000 ft. of pier and dock facing, which consists of sectional hollow concrete wall, 35 ft. wide and 39 ft. high. Each section is an 80 x 35 x 39-ft. concrete caisson, with reinforced outer walls 20 in. thick on all sides and seven intermediate 10-in. transverse walls. It has a solid bottom, thus forming a 2,500-ton caisson with eight separate compartments.

Concrete Plant.—The floating concrete plant is installed on a 40 x 120-ft. scow, and has large elevated storage hoppers, from which sand and gravel are discharged by gravity to measuring-boxes below deck that deliver their contents by an endless belt and bucket conveyer to the mixer hopper. Cement is charged into an iron receptacle in the cement house and forced by compressed air through a 4-in. pipe to the mixer hopper.

Concrete is discharged from the mixer to a skip, which is hoisted to the top of a 120-ft. tower and distributed by a pipe to any point of the caisson form.

Drydock Construction Attempted.—The first two of the fifty-four caissons were built in a floating drydock, which, with the caisson, weighed about 6,000 tons. While attempting to launch the caissons from the drydock the latter canted so much as to cause the caissons to slip transversely, overturning and wrecking the drydock. The caissons were subsequently recovered, floated three miles to the required site, and successfully sunk to position. No further attempts were made to use a drydock for the caissons.

Handling Caissons on Rolling Platforms.—A 90 x 225-ft. wooden pile skeleton pier has been built in water about 40 ft. deep, six miles from the pier site, and here five caissons are constructed at once on separate 40 x 100-ft. beds rolling on 4-in. double-flange cast-iron rollers, spaced 10-in. centres on 12 lines of 8 x 1-in. track rails.

The finished caissons are successively pulled transversely on to the launching cradle by two 13-part tackles rove with ¾-in. wire rope and operated by 7 x 10-in. hoisting engines.

The launching cradle is a ballasted wooden scow about 90 ft. long, 38 ft. wide and 7 ft. deep at the lower end, the bottom inclined to match the 1 : 18 slope of the pile trestle ways, 700 ft. long. The cradle is set on 4-in. double-flange cast-iron rollers on seven lines of 7 x 1-in. track rails, and before launching is held in position by four 8 x 1-in. anchor straps.

At the beginning of the launch, the caisson moves by gravity and is held back by a 29-part wire rope tackle operated by a 10 x 12-in. hoisting engine. Near the foot of the launching ways the caisson having developed retarding buoyancy, has to be pulled down by an auxiliary 7 x 10-in. hoisting engine. This plant has a capacity of one caisson every seven days. It was designed, constructed and operated by Grant Smith & Co. & McDonnell.

THE DISCHARGE FROM VERTICAL PIPES.*

By C. E. Grunsky.

WHILE assistant state engineer of California from 1881 to 1888, I had to examine many artesian wells and found it necessary early in this experience to devise a formula that would enable a quick estimate of discharge, using as basic elements the diameter of the well and the height to which the outpouring water rose above the top of the well-casing.

The formula which proved satisfactory was made public in a paper read before the Technical Society of the Pacific Coast on October 3, 1884, and has not, so far as I know, been superseded by anything better. Although the formula was based on but few experiments, it is fairly dependable when applied to wells that are four inches or more in diameter, and may be equally so for smaller wells, but on this point I have no information.

Let D = discharge in cu. ft. per second.
d = inside diameter of the casing in feet.
h_0 = height in feet to which water rises in the centre over the top of the casing.

Then as originally written:

$$D = \frac{10 d \sqrt{h_0^3}}{\sqrt{1 + 2.525\left(\frac{h_0}{d}\right)^2}} \qquad (1)$$

$$\text{or } D = 10 d^2 \sqrt{\frac{h_0}{d^2 + 2.525 h_0^2}} \qquad (2)$$

$$\text{or } D = 10 d^2 \sqrt{\frac{h_0}{\left(\frac{d}{h_0}\right)^2 + 2.525}} \qquad (3)$$

When h_0 is small in comparison with d, the denominator in (1) approaches unity, and, with sufficient accuracy for the special case in which the rise of the water above the top of the casing is less than one-tenth of the diameter of the casing, the formula may be written

$$D = 10 d \sqrt{h_0^3} \qquad (4)$$

and the similarity of the formula to that for a sharp-edged weir will be recognized.

If in this formula the length of the weir crest $3.1416d$ be introduced it will be seen that

$$D = (3.18d)\,(3.1416)\,\sqrt{h_0^3}.$$

whereas the well-known Francis weir formula would make, for the special case under consideration,

$$D = (3.33d)\,(3.1416)\,\sqrt{h_0^3}$$

The formulæ (1), (2), (3), and (4) are applicable to the flow from vertical pipes, of wrought iron or other thin material such as ordinarily used for well-casing.

When h_0 is small, overfalling water may adhere to the outside surface of the casing. In this event before h_0 is measured the water film must be broken and air admitted under the overfalling sheet of water. To measure h_0 a thin scale, with knife edge, may be used. The measurement is made at two points at the opposite end of a diameter with the scale held radially so as to offer least obstruction. Care must be taken to sight for both readings in the same horizontal plane. The top of the water dome will generally be undulating and the observation should continue long enough to get its mean elevation and not the extreme momentary rise of the water at the centre. The value of d is the mean of two inside diameters at right angles to each other.

The well-borer's practice, when he has finished his work, is to wet a saw-blade, cover the same with fine sand or dust and place the same back down, on edge across the top of the casing. The extreme height of the sand washed off is his estimate of the rise of the water above the top of the casing. This method of determining

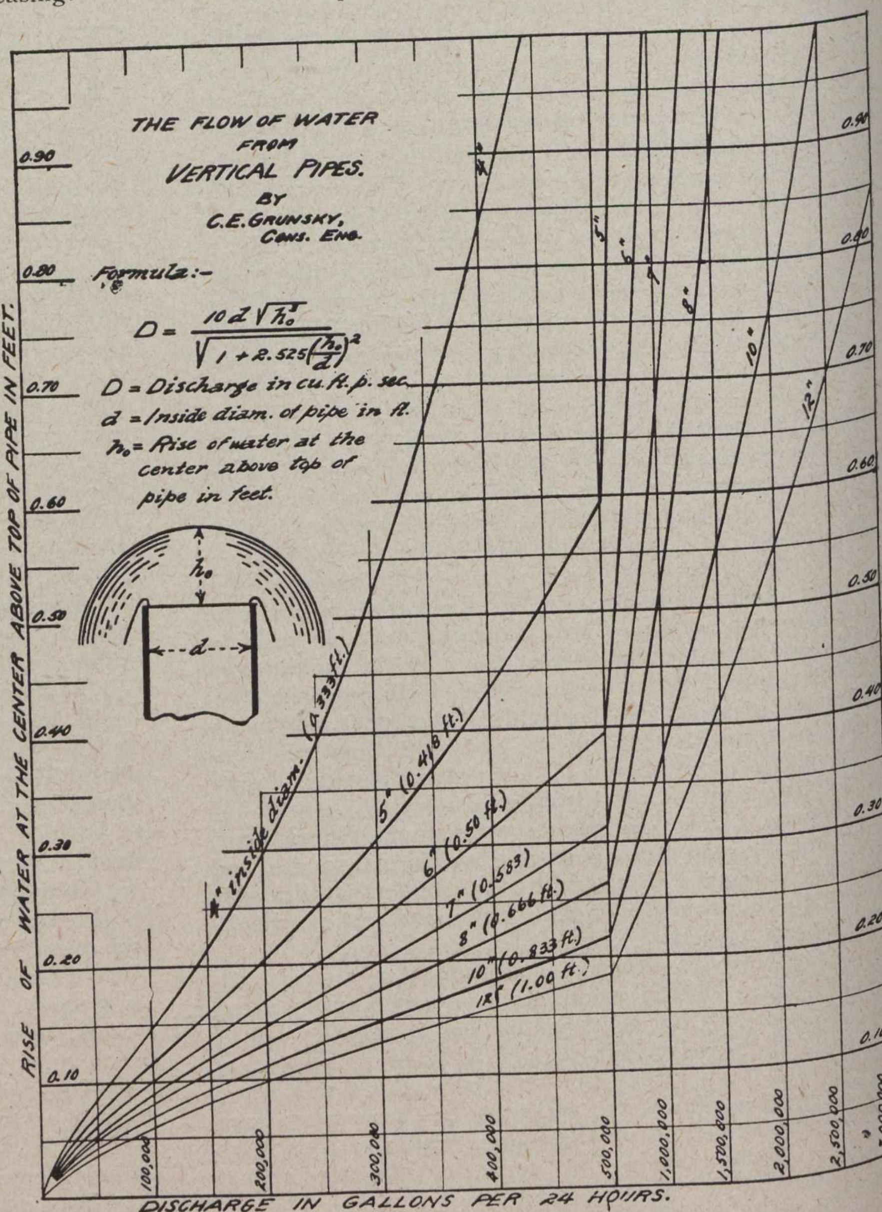


Chart for Computing Discharge.

h_0 would give too large a value and is not, therefore, advisable when the formula is to be applied.

Example: What is the flow in gallons per 24 hours of an 8-in. artesian well in which the water is found to rise 3 ins. (0.25 ft.) above the top of the casing?

Let it be supposed that the average of the two diameters which were measured is exactly 8 ins., then:

$$\frac{d}{h_0} = 2.667 \text{ and } \left(\frac{d}{h_0}\right)^2 = 7.11$$

$$D = 10 \times 0.667 \times 0.667 \sqrt{\frac{0.25}{7.11 + 2.525}}$$

D = 0.715 cu. ft. per second = 460,000 gallons per 24 hours.

*Abstract from a paper published in the Transactions of the Technical Society of the Pacific Coast.

USE AND CARE OF EXPLOSIVES.*

By Dr. R. E. Somers,
Department of Geology, Cornell University.

EXPLOSIVES are divided into two classes which may be designated simply as low explosives and high explosives. As an example of the former, there is ordinary black powder, or gunpowder, and among the latter are the dynamites, blasting gelatine, gelatine dynamites, picric acid and other nitro-explosives.

This difference in explosive power is due to the way in which the two essentials of the explosive reaction, namely, the material which oxidizes or burns, and that which furnishes the oxygen for the combustion, are combined. Gunpowder, for instance, is simply a mechanical mixture of charcoal, sulphur, and potassium or sodium nitrate. The charcoal and the sulphur burn, while the nitrate furnishes the oxygen for burning. In an explosive like dynamite, however, the constituents are not mixed mechanically, but are combined chemically, so that the material that burns, and the material that furnishes the oxygen are bound together in a chemical compound. It is small wonder, then, that such an explosive as gunpowder should be of low power, while one like dynamite should be of high power.

Incidentally, nitroglycerine, one of the high explosives, is made by the action of nitric acid on glycerine. When first made, in 1847, it was found to be very sensitive to shock and friction, and as a result they set about finding some way to get the explosive effect of nitroglycerine without so much danger in handling it. In order to get that result, Alfred Noble in 1865 hit upon the idea of absorbing it in something porous, like diatomaceous earth, a cellular siliceous powder, and by means of this absorption, cushioning the sensitive nitroglycerine enough to reduce the dangers of handling it, while at the same time retaining most of its explosive power. This mixture was called dynamite. The absorber is called the "dope," and while the first dope was diatomaceous earth, the ones used now are such as sawdust, wood meal, or a nitrate of potassium or sodium, which burn at the moment of explosion and thereby utilize the small amount of oxygen set free by the combustion of the nitroglycerine.

Guncotton is selected cotton, acted upon by nitric acid. It is usually compressed because it explodes better in that condition, and is the basis of many military explosives.

Blasting gelatine and the gelatine dynamites are often used in engineering and contracting work. The former is made by dissolving a small quantity of soluble guncotton in nitroglycerine and gelatinizing the solution in such a way that the dangers of handling it are somewhat reduced. This gelatine may then be absorbed in sawdust or some other dope giving a gelatine dynamite.

Contractor's powder consists of a small quantity of nitroglycerine absorbed in gunpowder as a dope. In a way, therefore, it possesses intermediate properties between the two.

In considering the care necessary in handling explosives, the two classes must be treated separately. Gunpowder, or black powder, is not sensitive to shock, percussion, or friction. Therefore it is not necessary to be careful about dropping it, or to prevent the slightest friction in manipulating it. It is undoubtedly true that black powder can be exploded by striking it, on an anvil, with a hammer, metal upon metal in other words, but except under such very extreme treatment it can be handled roughly with comparative safety. The principal thing about taking care of it is to keep it dry. A good idea of the condition of gunpowder may be gained by pouring out a small quantity on a sheet of white paper. When rolled from one part of the paper to another it should leave no dust. Dust is fine-grained, mealy powder that may have been left in the manufacture and serve to lessen the effects of the explosion, or it may be the result of moisture in the powder, which of course is a mark of deterioration. If this powder then be ignited, it should burn up without leaving a residue and without burning the paper. If black spots are left, it means that there is too much charcoal, or that the materials have been improperly mixed. Yellow spots indicate an excess of sulphur. If holes are burned in the paper, the powder is too moist. Although affected by moisture, it may still be brought back to good condition by drying, unless there are white spots on the grains. These indicate that the nitrate has leached out because of the moisture, and that the powder is practically spoiled, as far as getting the best efficiency out of it is concerned.

The high explosives, however, require much more careful treatment because of their sensitiveness. In the case of the dynamites, this is due to the sensitiveness of the nitroglycerine or the blasting gelatine from which they are made, and the cushioning by absorption in a dope is only partially effective. The percentage by which a dynamite is designated refers to the percent. by weight of nitroglycerine or gelatine in the cartridge. The remainder is absorbent. Since, therefore, the lower grade of dynamites contain much more dope in proportion to explosive, than do the higher grades, the explosive itself is better cushioned, and the dynamite less sensitive. The higher grades, on the other hand, are cushioned to a less degree, and are apt to be much more sensitive. Thus, a dynamite of small percent. can be handled more freely and with less care than one of large percent.

Dynamites should be stored in a building separate from any habitation, so that in case of an accidental explosion there will be no further damage than to the building itself. The explosive must be kept dry. There should be no metal used in moving the boxes of explosive, or in opening them, because at times nitroglycerine may leak out of the cartridges into the wood of the boxes and if this should be struck by a steel wedge or chisel, an explosion would be very apt to follow. Copper wedges are safer than steel or iron, but wood is the best. No flame lights, such as lamps or candles, should be allowed in the storehouse. The building itself should be heavy enough to afford complete protection against the weather.

The condition of dynamite can be told fairly well by an inspection of the cartridges. There should be no greasy material on the outside of the paper, since its presence means that the nitroglycerine is leaking out and the dynamite is dangerous. The sticks should have no white spots on them. These indicate that sodium nitrate has been used in the dope, that it is absorbing water, which it does easily, and that it is leaching out on the surface, thereby decreasing the value of the material as an explosive. Furthermore, there should be no green color about the stick. Nitroglycerine, under certain conditions, decomposes, with the liberation of green nitrous oxide gas. Such decomposed nitroglycerine is very dangerous, and hence if there are any green spots on the outside of the stick or underneath the paper, the dynamite should be spread out on the ground, at a distance from any habitation, and burned.

The most important thing, however, in the handling of the high explosives, is the thawing of dynamite that has frozen. Dynamite, or the nitroglycerine in dynamite

*In Cornell Civil Engineer.

freezes at from 42° to 46° F., in other words, from 10° to 14° higher than water. Not only does it freeze thus easily, but when frozen it is very sensitive to breaking, percussion or friction, and yet cannot be exploded well in blasting. It therefore must be thawed, while at the same time the dangers of the operation are many. There have been very many accidents in thawing dynamites, due chiefly

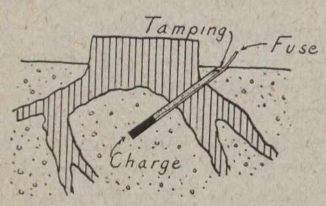


Fig. 1.

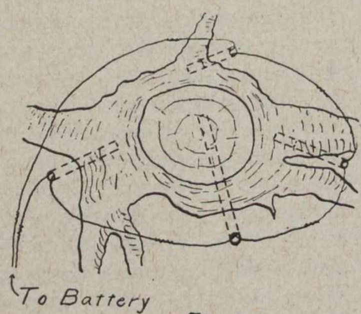


Fig. 2.

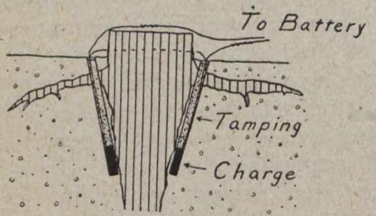


Fig. 3.

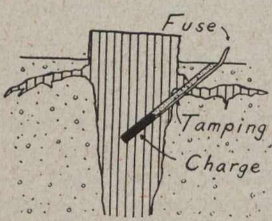


Fig. 4.

to the crude methods which have been employed. It is quite common to heat a flat stone in a fire, and then lay the stone off to one side and put the dynamite on it; ovens are filled with dynamite; a griddle is set off the stove and the sticks placed upon it; the sticks are laid on top of a boiler; they are put in hot water, or even thawed with a candle. Such methods are exceedingly dangerous, because they violate, in every case, two important principles. In the first place, nitroglycerine will leak out of dynamite when the latter is heated. Warm nitroglycerine is doubly sensitive and if a drop of it fall from the stick onto a stone, or stove, or kettle, an explosion is sure to result. In the second place, the dope has a greater affinity for water than for nitroglycerine, so that when dynamite is placed in water, especially if the latter has been heated, the water displaces the nitroglycerine, and forces it out of the cartridge. Again, there are liberated sensitive drops of a liquid that will explode upon the slightest provocation.

There are, however, many ways in which dynamite can be thawed with perfect safety and most of them consist of warming it, to a moderate degree, by means of hot water, but not in contact with it. Most of the thawing kettles put out by the explosives manufacturers consist of two compartments, one for the sticks of dynamite, and the other for the water that has already been heated. The kettles themselves should never be placed on a stove. A thaw house may be built, and kept at the right temperature by means of cans of hot water, or by hot water heaters.

In choosing an explosive for any blasting operation, it must be recognized that the different explosives have somewhat different behaviors. A low explosive, like gunpowder, has a comparatively slow, lifting or heaving action. It, therefore, is the proper explosive to use on clays or sands that are not consolidated. A high explosive, like dynamite, has a quick, shattering action, and the higher the grade of dynamite, the quicker its explosive effect. Consequently, a high explosive should be used on the consolidated rocks, and the harder the rock and the finer it needs to be broken up, the higher the grade of explosive that should be used.

There is not much that is to be said that is definite on the theory of blasting. The effects of an explosion are spent upon shearing the rock, lifting the rock and the air above it and heating the rock. Both the rocks, and the explosives themselves are extremely variable, and hence blasts are made under very widely varying conditions. It is therefore impossible to determine the quantitative effect of a unit weight of explosive, and formulate rules for the amount of explosive to use, and the depth and spacing of holes in any given instance. The best way is to profit from the experience of others on similar operations and to experiment with their quantity factors to make them fit the work at hand.

As an introduction to the latter part of my subject, namely, the use of explosives in highway construction, it would be well to note that there are proper as well as improper ways of priming a cartridge of dynamite. One end of the fuse should be cut off square and clean, and over that end the cap should be carefully placed. It should not be forced on if the fuse is too large, but the latter should be whittled to the right size. The cap should be crimped onto the fuse by means of crimping pliers, and never by means of the teeth. Then a hole is punched in the end or side of the cartridge with a wooden stick or with one of the handles of the crimper, the cap inserted, and the fuse tied to the cartridge with a string. This allows the primer to be lowered down the drill hole without danger of pulling out the cap, and is very much better than the half-hitch which many blasters make around the cartridge. In case an electric exploder is used instead of a fuse cap, the procedure is similar.

The principal uses to which the highway engineer may put explosives are, (1) the removal of stumps, (2) the breaking the boulders, (3) the removal of obstructing ledges and (4) the blasting of drainage ditches.

For the removal of stumps, holes should be bored underneath the stump by means of an earth auger. Figs.

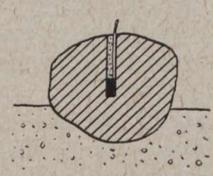


Fig. 5.


Fig. 6.


Fig. 7.

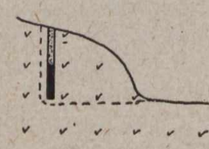


Fig. 8.

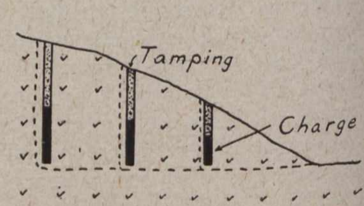


Fig. 9.

1-4 indicate the placing of these holes for stumps of different kinds and sizes. For a small stump, one hole is sufficient, as shown in Fig. 1. It should not be bored too flat, because the tendency then will be to split the stump rather than to tear it loose. In case of a large stump (Fig. 2) several holes should be bored. Where a tap root is to be removed, the holes may be placed as in Figs. 3 and 4. Dynamite of low or medium grade is used, and for a stump of moderate size one to three sticks are sufficient, while for a large stump, such as shown in Fig. 2, from one to three sticks per hole are required. The last stick is primed with a fuse cap or an electric detonator, or cap, except in a case like Fig. 2, when it is necessary to fire all the holes simultaneously and electric firing is demanded. In any case the hole must be tamped.

There are three methods by which boulders may be broken up. The one illustrated in Fig. 5 is called block-holing. A hole is drilled about half-way through the boulder, charged with a small amount of medium to high-grade dynamite, primed with a fuse or an electric detonator, and well tamped. This is economical in powder consumption, and the best method where there are many boulders to blast. Fig. 6 illustrates mud-capping. One or two sticks, primed, are laid on the flat surface of the boulder, and a 6-inch thickness of mud or clay pitted down on top. This is a very handy method but uses explosives rather wastefully. Fig. 7 shows undermining, or the snake-hole method. A hole is bored under the boulder and charged with from one to three sticks of dynamite. This method requires an intermediate amount of explosives and labor.

Blasting to grade often requires the removal of projecting ledges and this may be accomplished by placing rows of holes as shown in Figs. 8 and 9, firing one row

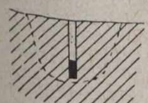


Fig 10.

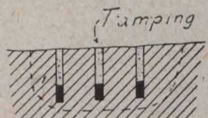


Fig 11

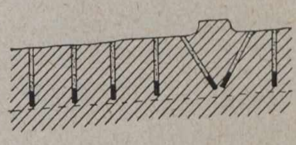


Fig. 12.

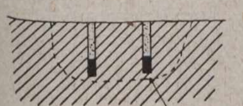


Fig. 13.

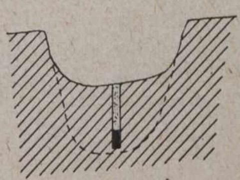


Fig. 14.

at a time, and thereby evacuating along the dotted lines shown. These holes should be placed a distance apart along the rows, and a distance back from the edge of the cut, equal to their depth, except when very deep, in which case they should be closer and nearer to the edge than their depth. They should be loaded from one-third to one-half of their lengths with low or high grade dynamite, according to the hardness of the rock. They should be well tamped, and should be fired by fuse or electricity.

By exploding one or more rows of vertical holes, drainage ditches may be blasted in soft materials. Figs. 10 to 14 show the way in which the holes are placed, Figs. 10, 11, 13 and 14 in cross-section, and Fig. 12 in longitudinal section. The holes should be about the same depth as the ditch desired, which, for Figs. 10-12, might be from 1½ to 5 feet deep. If greater depth is desired, the operation may be carried on as illustrated in Figs. 13 and 14. The holes should be from 1½ to 4 feet apart along the rows, charged with from one to three sticks of dynamite of medium or low grade, and fired simultaneously. Where the ground is actually saturated with water, this may be accomplished by one or two caps for each row of holes, but otherwise each hole should be primed.

In conclusion, if explosives are properly handled they are not especially dangerous, and there are many operations in road construction where their use means a saving of time, labor and materials.

CONCRETE PAVEMENTS IN CANADA.

IN connection with the "Review of 1915 Paving Work," published in May 11th issue of *The Canadian Engineer*, it is of interest to note that "Concrete Roads," a new booklet that is now being distributed by the Canada Cement Co., Montreal, contains the following authentic list of concrete roads, lanes and streets laid during 1915 by Canadian towns and cities:—

Oshawa, Ont., 9,000 square yards; Leamington, Ont., 11,200; Essex, Ont., 6,430; Grimsby, Ont., 2,476; Ingersoll, Ont., 3,929; Bridgeburg, Ont., 16,960; Berlin, Ont., 2,083; Windsor, Ont., 20,111; Niagara Falls, Ont., 3,200; Fort Erie, Ont., 3,080; Sault Ste. Marie, Ont., 11,800; Walkerville, Ont., 5,168; Sandwich, Ont., 32,866; Ojibway, Sandwich and Sandwich West, 65,500; Chatham, Ont., 10,895; St. Thomas, Ont., 2,125; Cayuga, Ont., 1,907; Merritton, Ont., 2,835; London, Ont., 5,500; St. Catharines, Ont., 1,000; Toronto, Ont., 21,995; Toronto-Hamilton Highway, Ont., 196,520; Amherstburg, Ont., 5,000; Pointe du Lac, Que., 43,555; Cap Madeleine, Que., 25,805; Berthier, Que., 9,750; Three Rivers, Que., 50,633; Shawinigan Falls, Que., 10,000; Ste. Rose, Que., 11,000; Westmount, Que., 9,455; Steel Co. of Canada, 400; Harbor Commissioners, 9,760; LaSalle, Que., 2,347; Pointe aux Trembles, 11,436; St. Anne de la Perade, 1,774; Amherst, N.S., 17,439; St. Vital, Man., 37,480. Total, 682,414.

The following interesting tables are also contained in the above-mentioned booklet:—

Square Yards Concrete Highways in Canada (by Provinces).

Province.	Prior to 1909.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	Totals.
Alberta	.....	1,319	114,676	10,020	13,895	53,413	10,683	....	204,006
British Columbia	.....	.....	10,283	28,075	31,899	40,414	36,371	....	147,042
Manitoba	.....	.....	......	......	......	52,594	43,466	37,480	133,540
New Brunswick	.....	.....	......	......	......	540	......	......	540
Nova Scotia	.....	.....	......	......	......	650	10,670	17,439	28,759
Ontario	72,806	23,664	17,831	26,055	130,569	209,366	297,734	441,580	1,219,605
Quebec	.....	.....	......	5,745	37,805	112,023	151,391	185,915	492,879
Saskatchewan	.....	.....	16,000	16,710	......	....	....	....	32,710
Totals	72,806	24,983	158,790	86,605	214,168	469,000	550,315	682,414	2,259,081

Number of Municipalities in Canada that Have Used Concrete for Paving Surface.

Classification.	Up to 1909.	1910.	1911.	1912.	1913.	1914.	1915.
Streets	4	7	7	14	30	30	28
Roadways	0	0	1	3	7	6	7
Lanes	2	1	1	2	2	6	2
Totals	6	8	9	19	39	42	37

Edwin S. Fraser, town engineer of New Glasgow, N.S., states that 5,940 sq. yards of bitulithic were laid in 1915, and 8,200 yds. of concrete sidewalks. Total pavements laid to date are 11,100 sq. yds. of bitulithic. About $12,500 will be spent this year on new pavements. It is planned to lay about 6,000 sq. yds. of concrete.

The Barrett Co., of New York, has now issued a 20-year guaranty bond of all Barrett specification roofs of 50 squares or more in the United States and Canada in towns of 25,000 population and over, and in small centres where their inspection service is available, provided the roof is laid by a roofing contractor satisfactory to them and in strict accordance with the Barrett specification dated May 1st, 1916, and subject to the inspection and approval of that company. This is a new departure and one which should be of great value to architects, engineers and owners of industrial plants of all kinds throughout the Dominion. This proposal on the part of the Barrett Co. has grown out of the conviction that with workmanship properly safeguarded, a Barrett specification roof should last for a minimum period of 20 years without repairs. The issuing of such a bond is evidence of the company's faith in their product.

PROGRAMME OF CONVENTION OF THE AMERICAN WATERWORKS ASSOCIATION, NEW YORK, JUNE 5th TO 9th.

We have pleasure in publishing herewith the programme of this very important function. Any of our readers who have attended the conventions of this body before will recall how exceedingly interesting and valuable the papers and discussions have proven. It is very much to be hoped that Canadian members of the Association will make a very special effort to attend. Convention headquarters will be at Hotel Astor, New York.

Monday, June 5th, will be devoted to registration, meetings of special committees, etc., and a general "getting together."

The real business of the convention will get away to a good start, Tuesday, June 6th, at 9 a.m. The forenoon will be spent listening to the president's address, addresses of welcome and responses thereto by the president of the Association, Nicholas S. Hill, Jr. The following papers will be delivered that afternoon: "Experience with a Card Consumer's Ledger,"* E. W. Haseltine. "Interpretation of Waterworks Accounts"* (with lantern slides), Mark Wolff.

Wednesday, June 7th.

Forenoon Session.—9 a.m.—Presentation of papers. "Difficulties in the Design and Operation of Medium-sized Waterworks Systems,"* E. B. Black. "Pumping Machinery: Test Duty versus Operating Results,"* J. N. Chester. "Reservoirs"* (presented with lantern slides), Dabney H. Maury. "Prevention of Water Waste on Railroads"* (lantern slides), C. R. Knowles. Report of Committee on Electrolysis, Prof. Albert F. Ganz, Chairman.

Afternoon.—Trip to Kensico Dam.—The Department of Water Supply, Gas and Electricity, the Board of Water Supply of the city of New York and the active members of the American Waterworks Association in the New York Section territory have arranged a trip to the Kensico Dam. A special train will leave the Grand Central Station at 1.30 p.m. for Valhalla Station, on the Harlem Division of the New York Central Railroad. Surface cars pass the hotel, running direct to the station. Returning, train will leave Valhalla about 4.45 p.m., arriving in New York about six o'clock, in time for dinner.

Evening Session.—8 p.m.—Election of Nominating Committee. Selection of place for holding the 1917 Convention. (Associate members vote on place for holding Convention.)

Presentation of Papers.—"Pressure Filters"* (presented with lantern slides), Harold C. Stevens. "The Typhoid Toll"* (presented with lantern slides), George A. Johnson.

Thursday, June 8th.

Superintendents' Day.—Forenoon Session.—9 a.m. —Question-box and discussion of waterworks topics. A special programme, with questions and topics for discussion, will be issued for this day.

Afternoon Session.—2 p.m.—Superintendents' Day continued to 3 p.m.

3 p.m.—Special examination of exhibits in exhibition room, with demonstrations. Organ recital in the exhibition hall from 3 to 6 p.m.

(Papers marked with an * are printed in the June Journal of the Association.)

Chemical and Bacteriological Section.—Forenoon Session. — 9 a.m. — Presentation of papers. — "Some Aspects of Chlorination,"* Joseph Race. "The Mount Kisco Sewage Disposal Plant, Croton Watershed," Theodore DeLong Coffin and Frank E. Hale. "Some Problems of the State Water Laboratory," L. H. VanBuskirk. "Recovery of Spent Lime at the Columbus Water-softening and Purification Works," Charles P. Hoover.

Afternoon Session.—2 p.m.—"A New Raw Water Supply for the City of McKeesport, Pennsylvania," Edward C. Trax. "Tests for Bacillus Coli as an Indicator of Water Pollution," C. E. A. Winslow.

Evening.—8.30 p.m.—Informal reception and dance tendered to the president and delegates of the American Waterworks Association by the Waterworks Manufacturers' Association in the Hotel Astor. At 9.30 the award of prizes will be made to the Section of the American Waterworks Association having made the greatest gain in membership, and to the individual member of a Section having secured the largest number of members.

Friday, June 9th.

Forenoon Session.—9 a.m.—Presentation of Papers. —"The Selection, Installation and Test of a 1,000,000 Gallon Motor-driven Centrifugal Pump,"* S. R. Blakeman. "The Latest Method of Sewage Treatment"* (presented with lantern slides), Edward Bartow. "Copper Sulphate Treatment of St. Paul, Minnesota, Water Supply,"* Prof. N. L. Huff and Garrett O. House. Report of Committee on City Planning, Ernest P. Goodrich, chairman.

On Saturday, June 10th, the local committee of arrangements has made plans for excursions to various points of interest. Full particulars regarding the Convention, programmes, etc., can be secured by communicating with J. M. Diven, Secretary, Troy, N.Y.

C. H. Rust, city engineer of Victoria, B.C., states that $42,316 was spent by Victoria last year for 23,399 sq. yds. of sheet asphalt and 4,152 sq. yds. of asphaltic concrete. This amount included surface, base and grading. Approximately the same amount will be spent this year. Total pavements laid to date in Victoria are: Sheet asphalt, 54¾ miles; asphaltic concrete, ¼ mile; brick, ½ mile; concrete, ¾ mile; waterbound macadam, 12½ miles; bituminous macadam, 1½ miles; creosoted wood block, 3½ miles.

The difficulties experienced by trade, industry and agriculture in the forwarding of goods by rail were recently discussed at some length in the French Senate, when serious complaints were made of the long delays which are taking place. The causes of the crisis are the diminution in the quantity of rolling stock, as a result of the war, the defective circulation of the rolling stock, inadequate supply of labor, and the insufficient capacity of the sorting sidings, which were not prepared for war conditions. It appears that out of the total rolling stock in the country, 54,000 wagons were seized by the enemy, but as 3,000 German trucks were retained, and 7,000 Belgian wagons were available, the difference works out at 44,000 wagons. If to these are added approximately 20,000 wagons retained for military requirements, a total deficit of from 60,000 to 70,000 wagons exists. To remedy the matter, about 2,500 wagons are being obtained from England, which will release an equivalent number of French rolling stock. 24,600 new wagons have been ordered, and a further supply of 10,000 is in negotiation, all of which will be delivered in the present year beginning from this month. It is therefore expected that the difficulty will be progressively reduced, in conjunction with the improvements which are being effected in the circulation of the wagons.

The Engineer's Library

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto.

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Book Reviews:

BOOK REVIEWS.

Concrete on the Farm and in the Shop. By H. Colin Campbell, C.E. 128 pages, 5 x 7 ins., 51 drawings, cloth. Price, 75 cents.

This is a new book from cover to cover, illustrating and describing in plain, simple language many of the numerous applications of concrete within the range of the home worker. It deals with the principles of reinforcing, form construction, mixing by hand and machine, foundations, materials and reinforcing, and a great many other specific uses to which concrete can be put. Of concrete books there is no end, but this book would seem to fill a decided want so far as the non-technical concrete worker is concerned. The author has endeavored to translate technical expressions and technical terms into plain, everyday English, so that any one who can read can understand it. The text is accompanied by fifty-one simple drawings, in some cases these drawings being purposely exaggerated to better show what is meant.

Hydraulic Flow Reviewed. By A. A. Barnes, A.C.G.I., Assoc.M.Inst.C.E. Published by E. and F. N. Spon, Limited, London, and Spon and Chamberlain, New York. First edition, 1915. 158 pages, 6 x 9½ ins., with frontipiece and 11 folding plates, cloth. Price, $3.50. (Reviewed by John H. Parkin, B.A.Sc., University of Toronto.)

This book, written by an English engineer, is similar to that of Williams and Hazen, so familiar to hydraulic engineers in America. The general equation employed is of the same form, in the notation of the book $v = Km \propto iB$, but in this equation K, $\propto$ and B are constants for each type of pipe or channel, all three changing with a change in type while being independent of size or proportions.

In the first part of the book, which deals with the flow of water in pipes and channels, is given the method of determining the values of K, $\propto$ and B for each type, by a system of logarithmic plotting of published experimental results for the particular type. A tabulated test is given of equations for velocity, friction head and discharge for seventeen types of channel from cast iron pipe to a canal or river. For purposes of design the deterioration in carrying capacity is taken care of by the addition of a certain percentage to the required discharge.

A most valuable feature of the book is the portion (some fifty pages) in which are tabulated the results of 807 tests on which the equations are based. The data given is very complete, covering published results of tests on various classes of pipes and channels in many parts of the world. In these tables a comparison is shown in each case of the results by the author's equations and the test results, the agreement being very good.

The second part of the book is devoted to the consideration of the measurement of water and equations are evolved of the same general type, giving the velocity and discharge for V notches, weirs and circular orifices. The equations have the advantages that they contain no valuable coefficient and apply without limitation as to head, breadth, angle of notch, etc. The equations are based on published experimental data which is given in tabulated form in the book, together with the results as given by the author's equations showing the close agreement forming a valuable reference feature.

A number of large size logarithmic charts are provided for the solution of problems dealing with cast iron and steel pipes, channels, rivers, weirs and circular orifices.

The book forms a very concise review of the experimental work done on the flow of water and the tabulated data gives it a high place as a reference work. The author's treatment, while leading to equations similar to that of Williams and Hazen, is a step in advance through the elimination of the troublesome Chezy coefficient and the adoption of different values of the exponents for different channel types, which admittedly gives more accurate results than a single pair of exponents for all cases. The work should be of much value to hydraulic and irrigation engineers or those having to do with the flow or measurement of water.

American Civil Engineers' Pocket Book. Edited by Mansfield Merriman and fifteen associate editors. Published by John Wiley & Sons, Inc., New York. Third edition, 1916. 1,571 pages, 4¼ x 7 ins., 1,300 cuts and 550 tables, leather. Price, $5 net.

This is a new edition, being the third since the work was published in 1910. A great many minor changes have been made and some new matter has been added, the following being a short list of the more important: Azimuth of Polaris at Elongation, and other astronomical calculations; Statistics of Railroad Operation; New Specification for Cement Testing; Arches Under Water Pressure; Discharge and Friction Heads for Long Pipes; Biel's Formula for Flow in Pipes and Channels; besides other matter which makes each section more complete. The book now contains 41 articles, 31 tables, 103 cuts and 120 pages more than the second edition.

An entirely new section of 96 pages has been added covering harbor and river works. Frederick R. Harris, Corps of Engineers, U.S. Navy, is responsible for the section.

Wave action, wave protection devices, such as breakwaters, bars, for shore protection and channel regulation are fully taken up. Chapters on quays and landing places are very complete and well illustrated.

The chapter on wet and dry docks is deserving of special mention for its completeness in such small compass. Although this chapter is the largest of the six in the new section, covering as it does 27 pages, there is enough information contained in it to enable an engineer who is at all familiar with dock work, to design and construct almost any form of wet or dry dock. The illustrations are well chosen and easily understood.

Floating and sliding caissons and other special forms of steel constructed caissons for entrance gates are illustrated, but no attempt is made to go into the question of design. Evidently the author considers such work as being out of the scope of a civil engineer's pocket book. The design of floating dry docks is taken up with some detail and some cost data is added.

This pocket book, in its new form with the many minor changes, and additions which make the individual sections more complete, and the addition of the new section on harbor and river works, will undoubtedly find favor with a great many engineers who have not before found such a work to be so complete and covering nearly all their requirements.

The Web of Steel. By Cyrus Townsend Brady and Cyrus Townsend Brady, Jr. Published by Fleming H. Revell Co., New York.

It is seldom that a novel makes a special appeal to the engineering profession. This is the case, however, in "The Web of Steel," just published. It is a good romance, with an engineering flavor, and written by Cyrus Townsend Brady and Cyrus Townsend Brady, Jr. The father has several other novels to his credit and the son is a civil engineer. The preface states that the volume is a book for men, about men, and written by men. It has all the good points of a popular novel, and the writers say that whatever may be said of their fiction, they "rest confident in the engineering." As "no scientific course is necessary for the comprehension of the story," this interesting volume will be read not only by engineers, but also by their ladies. The story is divided into four parts under the following headings: I., Bridge; II., C-10-R; III., Dam; IV., Spillway.

The novel is a well-written narrative, and will hold the reader until the closing page. "The Web of Steel," by C. T. Brady and C. T. Brady, Jr. Published by Fleming H. Revell Company, New York.

Practical Design of Steel-Framed Sheds. By A. S. Spencer. Constable and Co., London, Eng. (Reviewed by A. J. MacDougall, Mechanical Engineer, Toronto Power Co.).

In the first chapters of this book, after analyzing the effect of wind stresses, standard designs of roof trusses for sheds and the stresses in the various members are given. The book is then concluded with descriptions of external coverings and attachments for buildings.

This book is recommended to the engineer who lacks the time to make the calculations and design his own trusses, but is not recommended to those who, lacking knowledge of structural calculations, would place on their structure a ready-made design of truss. The reviewer is of the opinion it will pay in almost all cases to have a competent structural engineer design the structural steel.

Air-Craft in War and Peace. By Wm. A. Robson. Published by Macmillan Company of Canada. Price, 75 cents.

This is a new book, just issued, on this all-absorbing topic, and is written in plain, non-technical language. It points out with wonderful clearness the important part that air-craft has come to play as weapons of war. The author attempts to lay before the general public some of the outstanding points that have been brought to the surface as the result of the use of air-craft in the present war. The book is well illustrated and exceedingly readable, and should be of great interest to those who are at all interested in the subject. It contains 176 5 x 7½-in. pages, bound in cloth, and will, no doubt, form a welcome addition to literature of the science.

Parks and Park Engineering. By Wm. T. Lyle, A.M. Am.Soc.C.E. Published by John Wiley and Sons (Inc.), New York. 129 pages, 38 half-tones, 5½ x 9 ins. Price, $1.25 net. (Reviewed by R. B. Evans, A.M.Can.Soc.C.E., Parks Engineer, City Hall, Toronto.)

In reviewing a work on Parks and Park Engineering one must be broad enough to admit that Engineering is a large subject. The author has compiled an interesting book on this subject, introduces several good points on carrying out grading and drainage, and is not afraid to help the student who wants to know the correct grade for a sewer.

He touches on one or two personalities with whom the ordinary reader might or might not be familiar, and does not go deeply into the important subject of roadways. The work, however, gives some results of the latest practices in road surfacing with oils, etc., suitable for the ever-increasing automobile traffic, and an account of some modern boulevard pavements.

Some ideas re the acquisition of parks would be excellent reading for those interested in the improvement of cities and towns.

The methods of survey are up-to-date and similar to those in use in Canada.

Chapter III., on Design, touches on some large city improvement work, as well as some detail of taking care of parks and roadways.

The importance of getting rid of water as quickly as possible by various methods is emphasized, but none too strongly, as this, to the writer, is one of the most important items in engineering work.

The last chapter, on Construction, shows how one can make a smooth road for others to travel, which is the work of the conscientious engineer, no matter what particular line he may be following.

General Specifications for Concrete Bridges. By Wilbur J. Watson, Mem.Am.Soc.S.E. Third edition. Published by the McGraw-Hill Book Co. (Inc.), New York. 70 pages, 8 x 11 ins., paper. Price, $1.00. (Reviewed by E. M. Proctor, Department of Bridges, City Hall, Toronto.)

These specifications, by the well-known author of "Concrete Specifications," are brought up to date in this, the third edition. The sections on Surface Finishing, Waterproofing and Quality of Materials have been rewritten. It is in these three branches of the subject that the greatest advancement has been made in late years. Many other radical changes have also been made throughout the book.

The general arrangement of the specifications is exceptionally good. There are twenty-seven sections, each section dealing with some distinct branch of concrete bridge building. The sections dealing with design are not as complete and well arranged as those sections dealing with construction. This is evidently the result of the author having viewed his work from the construction engineer's standpoint.

A few points might be mentioned to illustrate the above contention. The loading specifications call for the uniform live load to be 100 lbs. per sq. ft., sidewalk and road, regardless of the length of the bridge. The concentrated loads are, if anything, too heavy. A few diagrams showing wheel-spacing, etc., would have been a great help to the designer. In Section II., "Rules for Computing and Designing," "the length of span for reinforced concrete beams, girders, slabs, etc., computed as simple beams, shall be considered to be the clear distance between supports," is one of the clauses. Very few specifications are as liberal as this. In a general specification like this it would have been better to have given a graded scale of temperature ranges rather than a range for latitude 40° only. In concrete arches the temperature plays a very important part, and has generally a greater range than +35° Fahr., as specified. A clause dealing more fully with this would not be out of place. The specification for bonding of steel rods in concrete are very liberal. Fifty per cent. may be developed by a 90° bend, and deformed rods are allowed to be bonded in one-half the length of plain rods. The results of the recent tests, as published in Bulletin No. 71 of the University of Illinois, no not bear out these specifications.

Sect. IV., "Formulæ," hardly has a place in a specification. These formulæ are given in all test books and are quite standard. Formulæ Nos. 1, 16 and 17 are evidently printed incorrectly.

Sect. V., "Quality of Materials," is the standard requirement of the American Society for Testing Materials.

Sect. VI., "Proportioning, Mixing and Placing Concrete"; Sect. VII., "Placing Reinforcing Steel"; Sect. VIII., "Placing Concrete in Cold Weather"; Sect. IX., "Forms and Centres," are all very well written and arranged, and if followed will produce a high-class product.

Sect. X., "Surface Finish," and Sect. XI., "Waterproofing," are excellent, and cover in six pages the various methods of modern practice in this rapidly developing branch of engineering. Sects. XII. to XXI. treat the following subjects in an able and concise manner: "Reinforced Steel Construction," "Cast Stone and Blocks," "Concrete Piling," "Inspection and Tests," "Retaining Walls, Abutments, Piers, etc.", "Concrete Arches," "Reinforced Concrete Slabs, Beams, Girders, Columns and Trusses," "Foundations and Footings," "Timber Piling," "General."

The last six sections are a valuable addition to bridge specifications; they deal with the pavement on the bridge. The titles of the sections are. "Cement Walks, Concrete Curbs and Roadways," "Brick Pavement," "Asphalt Block Pavement," "Sheet Asphalt Pavement," "Wood Block Pavement," "Bituminous Pavement."

Taking the specification as a whole, there are few, if any, concrete bridge specifications that cover so much ground and yet are so concise and well arranged. No engineer will make a mistake in adopting these specifications.

Proceedings of the Pan-American Road Congress, held at Oakland, California, September 13, 14, 15, 16 and 17, 1915. (Reviewed by S. G. Talman, A.M.Can. Soc.C.E., Roadways Department, City of Toronto.)

This comprehensive collection of papers will prove a very valuable addition to the library of the highway engineer, and is instructive reading for the layman road user interested in good results and how to get them. To cite one example from the many, the paper, "Highway Indebtedness; Its Limitation and Regulation," deals with facts with which every taxpayer should make himself familiar. Besides the purely technical, the papers treat the subject from every possible viewpoint, such as historical, financial, legal, etc. American thoroughness marks the proceedings from beginning to end.

PUBLICATIONS RECEIVED.

Economic Methods of Utilizing Western Lignites.—Bulletin No. 89 of the United States Bureau of Mines.

The Canadian Railway Club.—Official proceedings, April, 1916. This issue contains a paper by S. J. Sargant on "The Railways of India."

The Resources of Tennessee, No. 2, Vol. 6.—A magazine devoted to the description, conservation and development of the resources of the State of Tennessee. This number contains articles on phosphates of Johnson County, Tennessee, and notes on manganese in East Tennessee.

A Matter of Opinion.—Issued by the Canadian Forestry Association, Booth Building, Ottawa. The pamphlet is from the pen of Robson Black, the secretary of the Association, and is designed as a warning with the object of preventing, as far as possible, the firing of our forests.

Reports, St. John, N.B.—A 400-page booklet containing the reports and accounts of the city of St. John for the year 1915. Includes reports by William Murdoch, city engineer; F. L. Potts, works commissioner; A. Winchester, superintendent of streets; and G. N. Hatfield, road engineer.

Patent Protection.—Issued by Babcock & Sons, patent attorneys, Montreal. Gratuitous distribution. Deals with protection of inventions in Canada, United States and abroad. Well indexed. Covers costs, patentability of inventions, time required to obtain patent, and many similar matters.

Regulations Respecting Highways, 1916.—Issued by the Department of Public Highways, Ontario. It contains the regulations of the Department of Public Highways with respect to county road construction, maintenance and repair under the Highway Improvement Act and the Ontario Highways Act.

Reasonable Regulation of Railroads.—A report submitted to the Joint Committee on the reasonable regulation of railroads, which committee was formed in March, 1915, by representatives of ten of the leading commercial organizations of Philadelphia. Copies of the pamphlet can be secured by addressing Mr. Emil P. Albrecht, 214 The Bourse, Philadelphia, Pa.

Standard Specification for Cast Iron Water Pipe and Special Castings. Issued by the Canadian Society of Civil Engineers. These specifications, which were approved for re-printing by the Annual Meeting of the Society held in January last, have now been issued. Contains thirty-four

6-in. x 9-in. pages. They will be found of peculiar interest to all those who have to do with the design, construction and maintenance of all kinds of waterworks, sewage, filtration and industrial plants.

Russian Trade Preliminary Report.—This is a reprint of articles dealing with Russian trade by Mr. C. F. Just, Canadian Special Trade Commissioner, and is issued as a supplement to the Weekly Bulletin of the Department of Trade and Commerce. The pamphlet contains a large amount of very valuable information that must be of considerable interest to those whose attention is being turned to Russian trade at this time. It contains 100 6½ x 9½-inch pages.

Steamboat Inspection Report.—This is a supplement to the 48th annual report of the Department of Marine and Fisheries for the fiscal year 1914-15. It contains the report of the chairman of the Board of Steamboat Inspection, list of steamboat inspectors and an alphabetical arrangement of all the steamers, machinery and hulls inspected in Canada during the fiscal year ended March 31st, 1915, and various other tables of peculiar interest to those who have to do with marine matters. It contains 160 6 x 9 pages.

Modern Development in the Sugar Industry.—An interesting brochure sent out by the J. G. White Companies of New York, devoted to an interesting description of the development of the sugar industry. Reference is made to the constantly increasing amount of capital that is coming to be invested in the sugar industry and to the announcement of the establishment of a sugar engineering department under the auspices of the White Companies, this department being designed to cover all the activities of the sugar industry.

Fourth Annual Report of the Manitoba Public Utilities Commission.—This report covers the period for the year ended November 30th, 1915. It contains 138 pages and a special feature of it is the very exhaustive report of Albert F. Ganz, consulting engineer, on what he found in his investigations for stray electric currents in the city of Winnipeg and adjoining municipalities. The report also deals with the Winnipeg River Power Company, the Utilization of Domestic Coal, the Natural Resources of the Province, the Annual Report of the Manitoba Government Telephones. The report will be found of great interest to many who are concerned with the administration of public affairs in general.

Rules for Conducting Performance Tests of Power Plant Apparatus.—This is a report of the power test committee appointed by the American Society of Mechanical Engineers in April, 1909, to revise the present testing code of the Society relating to boilers, pumping engines, locomotives, steam engines in general, internal combustion engines, and apparatus and fuels therefor, and to extend these codes so as to apply to such power-generating apparatus as the present codes do not cover, including water power, bringing them into harmony with each other and with the best practice of the day. This report, which contains 218 pages, will be found of considerable interest to many of our readers, especially those of them who are connected with hydro-electric practice. It contains rules for conducting tests of all classes of power apparatus. The committee has gone into this matter very thoroughly, indeed, and practically almost every point is touched. Those who are interested will probably be able to secure a copy of the report by addressing Calvin W. Rice, Secretary of the American Society of Mechanical engineers, New York.

COAST TO COAST

Montreal, Que.—More than two thousand guests witnessed the launching of the "J. D. Hazen," the second largest ice-breaker in the world, from the shipbuilding yards of the Canadian Vickers, Limited, at Montreal, May 15th.

Peterborough, Ont.—The Appellate division has dismissed the appeal of the city of Peterborough from the decision of Justice Britton upholding the award of the arbitrators who fixed $154,615 as the amount to be paid by the city for the plant of the Peterborough Light and Power Company, Limited, which the city took over. The application by the city to examine the arbitrators as to their award is also dismissed.

Vancouver, B.C.—Arrangements for continuing the geodetic survey of the British Columbia coast, started last year, are being made by Mr. Noel J. Ogilvie, assistant superintendent of the Dominion Geodetic Survey Department, who is in charge of the extensive operations on the Pacific seaboard. Two small parties in charge of Mr. W. H. MacTavish, an engineer of the department, left for Prince Rupert recently to commence observations off Dixon Entrance.

The Pas, Man.—The Ottawa government will not undertake the expense of surveying the boundary line between Manitoba and Saskatchewan, north of 60, to determine the location of Flin-Flon and Athapapuskow Lakes. This information was contained in a letter to the Board of Trade from J. H. Challoner, head of the survey branch of the Department of the Interior. The status of the sulphide ore lakes will remain unknown until the survey is made.

Montreal, Que.—On the mezzanine or sacking floor of the $800,000 addition to Elevator No. 1, Lady Borden recently gave the signal which started the machinery in motion for the first time and opened the bin valve to allow a continuous stream of wheat to fall out on the ever-moving belt beneath. In so doing she inaugurated the active life of what is now the largest seaport elevator in the world, the new addition giving elevator No. 1 a total capacity of 4,000,000 bushels.

Montreal, Que.—Gigantic steam shovels weighing 65 tons each, capable of eating up the earth at the rate of 150 to 200 cubic yards an hour, and self-propelling extension track pile drivers, are part of the equipment recently purchased by the government for Col. C. W. P. Ramsay, of the Canadian Overseas Railway Construction Gorps. This plant was selected by Col. Ramsay's colleagues in the engineering department of the Canadian Pacific Railway and is being prepared by that company at the request of the government for shipment abroad.

Fort William, Ont.—The city of Fort William still does not desire the Canadian Car and Foundry Company to sell its Fort William plant to the Russian government. The company some years ago received certain concessions for building the establishment there, but the plant, although completed, has not operated yet. The city recently had a visit from Mr. W. W. Butler, vice-president, and Mr. K. W. Blackwell, one of the directors of the company, who met the council and discussed with them the question of the removal of the car plant from Fort William. The council met last month and the case on behalf of the car company was presented. After full discussion a motion was adopted that council was not favorable to the removal of the car plant.

Editorial

ACTIVATED SLUDGE.

It is questionable whether the optimist could have predicted the great developments which have been and are taking place in connection with the activated sludge process. Prof. Gilbert J. Fowler announced in 1913 the results of experiments made at the Manchester sewage works by adding iron salts, inoculation of sewage with an organism and blowing in air, which produced a "limpid, sparkling and non-putrefactive effluent." This research was undertaken because of a suggestion made to him by Dr. Maclean Wilson that it might be possible to "discover some kind of clotting enzyme which should do the work which now apparently takes place on the surfaces of the medium of the filter bed." Dr. Fowler, when reading a paper before the Liverpool Engineering Society on March 4th, 1914, stated that he looked "forward with confidence to the time when it will be possible completely to purify sewage in a tank with the production on the one hand of inoffensive sludge which can be readily handled and disposed of as manure, and on the other of a well-aerated effluent."

In May, 1914, the world learned of the results obtained by Messrs. Ardern and Lockett, who were collaborating with Dr. Fowler and from that time to the present sanitarians have in many lands given the activated sludge process a great amount of consideration. Those who have kept in touch with the progress of sewage treatment during the past generation can recall the multitude of methods which were tried; but the standards of purification and the efficacy of the processes did not work out in practice according to the predictions of those who heralded their inception. Consequently, we have been waiting and observing, delving into Nature's mysteries and slowly bringing to light many valuable discoveries which in the aggregate have brought the science and art of sewage treatment within a measurable distance of the desired goal.

We have before us the report issued by the Milwaukee Sewerage Commission, the bulk of which deals with extensive experimentation in connection with the activated sludge process. The forward step taken by Mr. Chalkley Hatton, the chief engineer, and his chief chemist, Mr. William R. Copeland, in advising the Commission to construct a two-million-gallon-per-day plant, commands admiration, for no doubt many problems and difficulties are brought out, when operations are conducted on a large scale, which are often unobserved in the laboratory. Milwaukee experiments have revealed some of these. For example, the diffusion of air has, in practice, apparently not proved so easy of attainment as was originally anticipated. Mr. George W. Fuller has drawn attention to several points which deserve consideration, and no doubt with patient research they will be satisfactorily solved.

The process, nevertheless, is advanced sufficiently to indicate that it is applicable under a great variety of conditions. It will treat sewage containing large proportions of trade wastes which have hitherto caused great trouble, and also sewage which is entirely domestic; but in each case the treatment, although identical in principle, must be varied according to the strength and characteristics of the sewage. The effluents obtained by the process exceed in superiority those got by ordinary methods, even with ample area of filters and efficient sterilization. Furthermore, it was possible at Milwaukee to purify about 10 million U.S. gallons per acre, whereas only 2.5 millions are possible by the older methods.

The ordinary haphazard attention, however, will spell failure because, on the one hand, there must not be an accumulation of unoxidized sludge, nor, on the other, much exhausted sludge due to over-aeration. There is a great measure of flexibility in the process, for by aerating the sludge during the period of minimum flow and weak sewage it is possible to charge the incoming sewage during the other periods with vigorous activated sludge.

Whilst the effluent from these tanks is clarified and purified to a greater degree than is possible by ordinary sewage treatment, the sludge which has always been the great bugbear of sewage works is made valuable as a fertilizer, owing to the proportion of nitrogen, phosphorus and potash contained therein. Activated sludge drains easily and can be pressed into cakes. The use of lime, however, may probably be avoided by using fine ashes, coal or lignite dust, or dry peat, and it would be instructive if experiments were made on these lines. Screened cinders are found effective with ordinary sludge at Oldham, and Degeur used lignite in Germany. As activated sludge contains about 98 per cent. of water it will be seen that if the moisture content was reduced to 20 per cent. the weight would be reduced from 100 to 2.5, which is a most important factor in its manipulation.

Although Canadian municipal authorities will learn much by the work done by British and American experiments, there is more to be gained by carrying on similar work because there is a great deal of knowledge to be acquired by observing the particular features of the process under different conditions. No scientist can express in language all the knowledge he has gained, even if he should write volumes. It is the personal contact with a new process which reveals its full value.

The comprehensive experiments made at Milwaukee have so fully confirmed the statements made by Messrs. Ardern and Lockett that there remains but little doubt in the minds of sanitarians generally, that we are to witness a great revolution in the method of sewage treatment and the standards of purification which will in future be attainable in ordinary everyday practice.

AN INTERESTING ANNOUNCEMENT.

As indicating the confidence of the French people it is interesting to note that plans are now being formulated for the holding of a Reconstruction Exposition in Paris during May, June and July of this year. In a statement to manufacturers it is pointed out that the war has laid bare the habitations of 35,000,000 people and destroyed county roads, city streets, public service systems, factories and farms. This, indeed, is a most interesting announcement and indicates the spirit of the people. It spells hopefulness at least. The prospectus adds that the end of the war will mark the beginning of the work of reconstruction and for this a vast amount of machinery and supplies will be necessary.

PERSONAL.

H. D. CAMERON has been appointed mechanical engineer of the Canadian Northern Railway, with office at Toronto, Ont.

Prof. WM. NICOL, of Queen's University, has resigned after having been professor of mineralogy for twenty-five years.

C. A. COTTERELL has been appointed superintendent, district of Alberta division, Canadian Pacific Railway, with headquarters at Lethbridge.

J. E. B. PHELPS, former chief engineer of the Sarnia Electric Light Company, has been appointed general manager of the Sarnia (Ont.) Hydro Power Commission.

Sir ADAM BECK, chairman of the Hydro-Electric Power Commission of Ontario, has had the degree of LL.D. conferred upon him by Western University, London, Ont.

J. G. SULLIVAN, M.Can.Soc.C.E., chief engineer of the western lines, Canadian Pacific Railway, has been elected first vice-president of the American Railway Engineering Association for 1916-1917.

ALLAN PURVIS, superintendent of the C.P.R. at London, Ont., has been appointed general superintendent of the Eastern Division in place of A. E. Stevens, who has been transferred to a similar position at Moose Jaw, replacing J. G. Taylor, who had to relinquish his duties on account of ill-health.

W. GRANT FRASER, of New Glasgow, N.S., has been appointed under the Imperial Munitions Board, as chief inspector of all munition factories in the Maritime Provinces. Mr. Fraser has had a long experience in steel manufacture, having been one of the smelter foremen for the Nova Scotia Steel and Coal Co., both at New Glasgow and at Sydney Mines.

A. F. MACALLUM, C.E., M.Can.Soc.C.E., city engineer of Hamilton, Ont., has resigned to accept the position of works commissioner of Ottawa, Ont. Mr. Macallum was chosen unanimously by the Ottawa Board of Control at a meeting last Thursday morning, and his appointment was ratified by the city council at a special meeting held that evening. Mr. Macallum is president of the American Society of Municipal Improvements, and is one of the best-known municipal engineers in Canada. He is a graduate of the School of Practical Science, University of Toronto, and is a member of the American Society of Civil Engineers. For several years after graduation Mr. Macallum was engaged in railroad work. He was then appointed assistant city engineer of Toronto, and later entered private practice at Toronto. He has been city engineer of Hamilton for seven years. Mr. Macallum is an able and popular engineer, and carries with him to his new position the good wishes of all of his fellow Canadian engineers.

ANNUAL CONVENTION OF THE ROYAL ARCHITECTURAL INSTITUTE OF CANADA.

The General Annual Assembly of the Royal Architectural Institute of Canada will be held at Quebec, Que., on Saturday, 9th September, 1916. All Canadian architects are invited and a record attendance is expected. J. H. G. Russell, Winnipeg, Man., President. Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que., Hon. Secretary.

MANITOBA BRANCH CANADIAN SOCIETY OF CIVIL ENGINEERS.

The regular monthly meeting of the Electrical Section was held May 10th, when F. H. Martin gave a talk on "Water Wheels."

EDMONTON BRANCH CANADIAN SOCIETY OF CIVIL ENGINEERS.

The Edmonton Branch of the Canadian Society of Civil Engineers held their special meeting for the election of officers for the ensuing year on the 10th instant at the Cecil Hotel. About twenty members of the Society, resident in Edmonton were present.

After a pleasant and informal dinner, the business of the evening was taken up. The following officers were elected to be installed next October when the new season commences: Chairman, L. B. Elliot; vice-chairman, J. Chalmers; secretary-treasurer, C. A. Robb; executive committee, A. T. Fraser, D. J. Carter, J. L. Coté, D. Donaldson. After other regular business brought before the branch was disposed of, the meeting adjourned at 9.30.

AMERICAN SOCIETY FOR TESTING MATERIALS.

The nineteenth annual meeting of the American Society for Testing Materials will be held at Atlantic City, N.J., June 27 to 30. Headquarters for the meeting will be at the Hotel Traymore. A summarized programme of the meeting follows:—

First session, Tuesday, June 27, 11 a.m.—Minutes of eighteenth annual meeting; report of executive committee; various committee reports; announcement of election of officers; miscellaneous business.

Second session, Tuesday, 3 p.m.—Reports of committees on miscellaneous materials.

Third session, Tuesday, 8 p.m.—Presidential address and reports on heat treatment of steel.

Fourth session, Wednesday, 10 a.m.—Reports on steel and iron. Wednesday afternoon will be reserved for recreation.

Fifth session, Wednesday, 8 p.m.—Reports on tests and testing.

Sixth session, Thursday, 10 a.m.—Reports on cement and concrete.

Seventh session, Thursday, 3 p.m.—Reports on ceramics and road materials. Thursday evening will be reserved for a smoker.

Eighth session, Friday, 10 a.m.—Reports on non-ferrous metals and cast iron.

Ninth session, Friday, 3 p.m.—Reports on miscellaneous materials.

In connection with the forthcoming Convention of the American Water Works Association to be held in New York, June 5-9, it is proposed to take delegates, who so desire, to see either Kensico Dam and reservoir, in which is stored 38,000,000,000 gallons of Catskill Mountain water, the Ashokan Aerator at the beginning of the Catskill Aqueduct, or the new four truck double deck subway in rock tunnel in Lexington Avenue, New York City. No doubt many of the delegates will be glad to take full advantage of seeing these important engineering works.