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Formulae for One-Story and Two-Story Bents

Elastic Deformation Method Used for Exact Determination of Stresses in Simple Types of Structures—Equations Derived Analytically to Save Time for Designing Engineers Engaged in Steel or Reinforced Concrete Construction

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When designing one-story and two-story bents, without diagonals, subject to horizontal forces, engineers usually base their design upon some assumption as to the location of the points of contraflexure of the columns.

Following such assumption, the bending moments produced in the columns by the horizontal forces are easily calculated. It is evident, however, that the location of the points of contraflexure is dependent upon the relative moments of inertia of the columns and struts, since the stiffness of the struts as compared to the columns determines the amount of deflection at the joints. The results obtained by

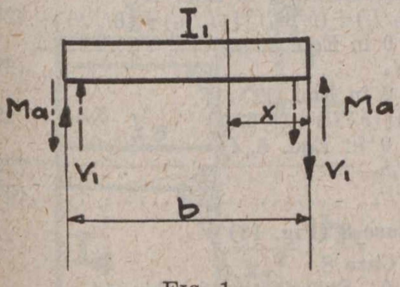

FIG. 1

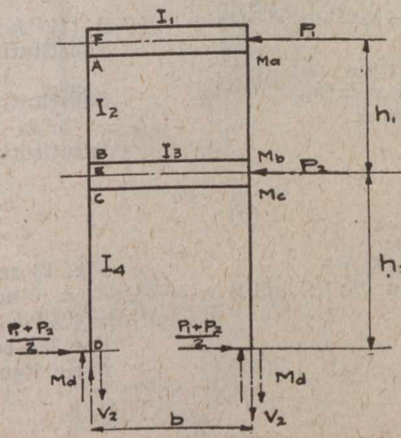

FIG. 2

this method of calculation are, of course, only approximate.

In this article, an analysis, based upon the elastic theory of structures, is made in order to determine the bending moments and the location of the points of contraflexure in the columns of a two-story bent. From the formulæ thus derived, the ten different cases illustrated by Figs. 6 to 15 are deduced.

If the structure be subject to vertical forces as well as horizontal, it is but necessary to make an algebraical addition of the stresses produced by the different forces.

In this article the following assumptions are made:—

(1)—That each column takes one-half the load.

(2)—That the connection of the column to the strut is rigid.

(3)—That the foundations are non-yielding.

All dimensions are expressed in the same units, and the following nomenclature is used:—

P_1 and P_2 Horizontal forces.

h_1 and h_2 and b Distances as shown in figures.

I_1 and I_3 Moment of inertia of upper and lower girder, respectively.

I_2 and I_4 Moment of inertia of upper and lower column, respectively.

M_a Moment at junction of upper column and upper girder.

M_b Moment at junction of upper column and lower girder.

M_c Moment at junction of lower column and lower girder.

M_d Moment at base of column.

x_1 and x_2 Distances to points of contraflexure.

Referring to Fig. 2, the moments about E may be expressed as follows:—

$$P_1h_1 = 2M_b + V_1b.$$

Solving for V_1,

$$V_1 = (P_1h_1 - 2M_b)/b \quad \ldots\ldots(1)$$

Again referring to Fig. 2, the moments about D may be expressed as follows:—

$$P_1(h_1+h_2) + P_2h_2 = 2M_d + V_2b.$$

Solving for V_2,

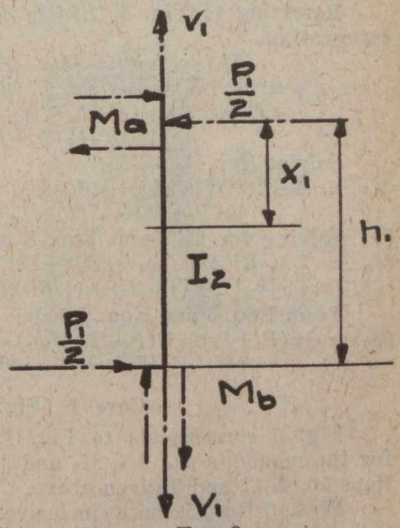

FIG. 3

$$V_2 = [P_1(h_1+h_2) + P_2h_2 - 2M_d]/b \quad \ldots\ldots(2)$$

Then,

$$V_2 - V_1 = [(P_1+P_2)h_2 - 2M_d + 2M_b]/b \quad \ldots\ldots(3)$$

Referring to Fig. 1, the moments about F are

$$V_1b = 2M_a.$$

Solving for M_a and substituting the value for V_1 from Equ. 1,

$$M_a = (P_1h_1/2) - M_b \quad \ldots\ldots(4)$$

Referring again to the moments about E (see Fig. 2),

$$(P_1+P_2)h_2 - 2M_d = 2M_c.$$

From this,

$$M_c = \tfrac{1}{2}(P_1+P_2)h_2 - M_d \quad \ldots\ldots(5)$$

The equation of the elastic curve (see Fig. 1) is

$$EI_1(d^2y/dx^2) = V_1x - M_a.$$

By integrating,

$$EI_1(dy/dx) = \tfrac{1}{2}V_1x^2 - M_ax + C_1.$$

When $dy/dx = (dy/dx)_A$, and $x = 0$,

$$C_1 = EI_1(dy/dx)_A.$$

By substituting in above,

$$EI_1(dy/dx) = \tfrac{1}{2}V_1x^2 - M_ax + EI_1(dy/dx)_A.$$

Integrating again,

$$EI_1y = \tfrac{1}{6}V_1x^3 - \tfrac{1}{2}M_ax^2 + EI_1(dy/dx)_Ax + C_2.$$

$C_2 = 0$. When $y = 0$ and $x = b$, substituting for V_1 from Equ. 1, and for M_b from Equ. 4,

$$(dy/dx)_A = M_a b/6EI_1 \quad \ldots\ldots (6)$$

For convenience, x and y axis will be turned through 90 degs. when considering vertical posts.

Referring to Fig. 3,

$$EI_2(d^2y/dx^2) = M_a - \tfrac{1}{2}P_1x.$$

By integrating,

$$EI_2(dy/dx) = M_a x - \tfrac{1}{4}P_1x^2 + C_1.$$

When $dy/dx = (dy/dx)_A = M_a b/6EI_1$, and $x = 0$,

$$C_1 = M_a bI_2/6I_1.$$

Substituting this value for C_1 in the above equation,

$$EI_2(dy/dx) = M_a x - \tfrac{1}{4}P_1x^2 + (M_a bI_2/6I_1).$$

When $dy/dx = (dy/dx)_B$, and $x = h_1$,

$$(dy/dx)_B = (dy/dx)_C = (M_a h_1/EI_2) + (M_a b/6EI_1) - (P_1h_1^2/4EI_2) \quad \ldots\ldots (7)$$

Referring to Fig. 4,

$$EI_3(d^2y/dx^2) = (V_2 - V_1)x - M_b - M_c.$$

Integrating,

$$EI_3(dy/dx) = (V_2 - V_1)\tfrac{1}{2}x^2 - (M_b + M_c)x + C_1$$

When $dy/dx = (dy/dx)_B$, and $x = 0$,

$$C_1 = EI_3(dy/dx)_B.$$

Substituting these values in the above equation,

$$EI_3(dy/dx) = (V_2 - V_1)\tfrac{1}{2}x^2 - (M_b + M_c)x + (M_a h_1 I_3/I_2) + (M_a bI_3/6I_1) - (P_1h_1^2I_3/4I_2).$$

Integrating again,

$$EI_3 y = (V_2 - V_1)\tfrac{1}{6}x^3 - (M_b + M_c)\tfrac{1}{2}x^2 + [(M_a h_1 I_3/I_2) + (M_a bI_3/6I_1) - (P_1h_1^2I_3/4I_2)]x + C_2.$$

$C_2 = 0$. When $y = 0$ and $x = b$,

$$(M_b + M_c)\tfrac{1}{2}b - M_a[(h_1I_3/I_2) + (bI_3/6I_1)] = (V_2 - V_1)\tfrac{1}{6}b^2 - (P_1h_1^2I_3/4I_2).$$

Substituting for $(V_2 - V_1)$ from Equ. 3, and for M_b and M_c from Equ. 4 and Equ. 5, respectively, and solving for M_d,

$$M_d = \tfrac{1}{2}(P_1h_1 + P_1h_2 + P_2h_2) - M_a\{1 + (6I_3/b)[(h_1/I_2) + (b/6I_1)]\} + 3P_1h_1^2I_3/2bI_2 \quad \ldots\ldots (8)$$

Referring to Fig. 5, $EI_4(d^2y/dx^2) = M_d - \tfrac{1}{2}(P_1 + P_2)x$.

Integrating,

$$EI_4(dy/dx) = M_d x - \tfrac{1}{4}(P_1 + P_2)x^2 + C_1.$$

$C_1 = 0$. When $dy/dx = (dy/dx)_c$ and $x = h_2$,

$$(M_a h_1 I_4/I_2) + (M_a bI_4/6I_1) - (P_1h_1^2I_4/4I_2) = M_d h_2 - \tfrac{1}{4}(P_1 + P_2)h_2^2.$$

Solving for M_d,

$$M_d = (M_a I_4/h_2)[(h_1/I_2) + b/6I_1)] + \tfrac{1}{4}(P_1 + P_2)h_2 - (P_1h_1^2I_4/4I_2h_2) \quad \ldots\ldots (9)$$

Solving for M_a from Equ. 8 and Equ. 9,

$$M_a = \{\tfrac{1}{4}(2P_1h_1 + P_1h_2 + P_2h_2) + (3P_1h_1^2/2I_2)[(I_4/6h_2) + (I_3/b)]\} \div \{1 + [(h_1/I_2) + (b/6I_1)][(I_4/h_2) + (6I_3/b)]\} \quad \ldots (10)$$

From Equ. 5 and Equ. 9,

$$M_c = \tfrac{1}{4}(P_1 + P_2)h_2 + (P_1h_1^2I_4/4I_2h_2) - (M_aI_4/h_2)[(h_1/I_2) + (b/6I_1)] \quad \ldots\ldots (11)$$

Case 1 (Fig. 6)

Fig. 6 corresponds to Fig. 1, and the four equations for the moments M_a, M_b, M_c and M_d are, respectively, equations 10, 4, 11 and 5 given above.

Figs. 7 to 15, both inclusive, are special cases, and the values for their moments were obtained by substituting the proper values in the above equations, as shown. Values for points of contraflexure were derived by equating the second derivative of the equation for the elastic curve equal to zero. For Case 1 (Fig. 6),

$$x_1 = 2M_a/P_1 \quad \ldots\ldots (12)$$

$$x_2 = 2M_d/(P_1 + P_2) \quad \ldots\ldots (13)$$

Case 2 (Fig. 7)

Fig. 7 represents Case 2,

$M_d = 0$. Substitute for M_d in Equ. 8.

$$M_a = [\tfrac{1}{2}(P_1h_1 + P_1h_2 + P_2h_2) + (3P_1h_1^2I_3/2bI_2)] \div \{1 + (6I_3/b)[(h_1/I_2) + (b/6I_1)]\} \quad \ldots\ldots (14)$$

For M_b, see Equ. 4.

Substituting $M_d = 0$ in Equ. 5,

$$M_c = \tfrac{1}{2}(P_1 + P_2)h_2 \quad \ldots\ldots (15)$$

For x_1, see Equ. 12.

Case 3 (Fig. 8)

Fig. 8 represents Case 3.

$P_2 = 0$, $I_3 = 0$, $I_4 = I_2$, and $h_1 + h_2 = h$. Substituting in Equ. 10,

$$M_a = (3P_1h^2I_1)/2(bI_2 + 6hI_1) \quad \ldots\ldots (16)$$

For M_b, see Equ. 4.

$$x_2 = 2M_b/P_1 \quad \ldots\ldots (17)$$

Case 4 (Fig. 9)

Fig. 9 represents Case 4.

$M_b = 0$. Substituting in Equ. 4,

$$M_a = P_1h/2 \quad \ldots\ldots (18)$$

Case 5 (Fig. 10)

Fig. 10 represents Case 5.

$P_2 = 0$. Substituting in Equ. 10,

$$M_a = \{\tfrac{1}{4}P_1(2h_1 + h_2) + (3P_1h_1^2/2I_2)[(I_4/6h_2) + (I_3/b)]\} \div \{1 + [(h_1/I_2) + (b/6I_1)][(I_4/h_2) + (6I_3/b)]\} \quad \ldots\ldots (19)$$

Substituting $P_2 = 0$ in Equ. 4,

$$M_b = (P_1h_1/2) - M_a \quad \ldots\ldots (20)$$

Substituting $P_2 = 0$ in Equ. 11,

$$M_c = \tfrac{1}{4}P_1h_2 + (P_1h_1^2I_4/4I_2h_2) - (M_aI_4/h_2) \times [(h_1/I_2) + (b/6I_1)] \quad \ldots\ldots (21)$$

Substituting $P_2 = 0$ in Equ. 5,

$$M_d = (P_1h_2/2) - M_c \quad \ldots\ldots (22)$$

For x_1, see Equ. 12.

$$x_2 = 2M_d/P_1 \quad \ldots\ldots (23)$$

Case 6 (Fig. 11)

Fig. 11 represents Case 6.

$P_2 = 0$ and $M_d = 0$. Substituting in Equ. 14,

$$M_a = [\tfrac{1}{2}P_1(h_1 + h_2) + (3P_1h_1^2I_3/2bI_2)] \div \{1 + (6I_3/b)[(h_1/I_2) + (b/6I_1)]\} \quad \ldots\ldots (24)$$

For M_b, see Equ. 20.

Substituting $P_2 = 0$ in Equ. 15,

$$M_c = P_1h_2/2 \quad \ldots\ldots (25)$$

For x_1, see Equ. 12.

Case 7 (Fig. 12)

Fig. 12 represents Case 7.

$P_1 = 0$. Substituting in Equ. 10,

$$M_a = (\tfrac{1}{4}P_2h_2)/\{1 + [(h_1/I_2) + (b/6I_1)][(I_4/h_2) + (6I_3/b)]\} \ldots (26)$$

Substituting $P_1 = 0$ in Equ. 4,

$$M_b = -M_a \quad \ldots\ldots (27)$$

Substituting $P_1 = 0$ in Equ. 11,

$$M_c = \tfrac{1}{4}P_2h_2 - (M_aI_4/h_2)[(h_1/I_2) + (b/6I_1)] \quad \ldots\ldots (28)$$

Substituting $P_1 = 0$ in Equ. 5,

$$M_d = \tfrac{1}{2}P_2h_2 - M_c \quad \ldots\ldots (29)$$

$$x_2 = 2M_d/P_2 \quad \ldots\ldots (30)$$

Case 8 (Fig. 13)

Fig. 13 represents Case 8.

$P_1 = 0$ and $M_d = 0$. Substituting in Equ. 14,

$$M_a = (\tfrac{1}{2}P_2h_2)/\{1 + (6I_3/b)[(h_1/I_2) + (b/6I_1)]\} \quad \ldots\ldots (31)$$

For M_b, see Equ. 27.

From Equ. 15,

$$M_c = P_2h_2/2 \quad \ldots\ldots (32)$$

Case 9 (Fig. 14)

Fig 14 represents Case 9.

P_2 acts in opposite direction to P_1. Substituting $-P_2$ for $+P_2$ in Equ. 10,

$$M_a = \{\tfrac{1}{4}(2P_1h_1 + P_1h_2 - P_2h_2) + (3P_1h_1^2/2I_2)[(I_4/6h_2) + (I_3/b)]\} \div \{1 + [(h_1/I_2) + (b/6I_1)][(I_4/h_2) + (6I_3/b)]\} \quad \ldots\ldots (33)$$

For M_b, see Equ. 4.

From Equ. 11,

$$M_c = \tfrac{1}{4}(P_1 - P_2)h_2 + (P_1h_1^2I_4/4I_2h_2) - (M_aI_4/h_2)[(h_1/I_2) + (b/6I_1)] \quad \ldots\ldots (34)$$

From Equ. 5,

$$M_d = \tfrac{1}{2}(P_1 - P_2)h_2 - M_c \quad \ldots\ldots (35)$$

For x_1, see Equ. 12.

$$x_2 = 2M_d/(P_1 - P_2) \quad \ldots\ldots (36)$$

Case 10 (Fig. 15)

Fig. 15 represents Case 10.

P_2 acts in opposite direction to P_1, and $M_d = 0$. Substituting $-P_2$ for $+P_2$ in Equ. 14,

$$M_a = [\tfrac{1}{2}(P_1h_1 + P_1h_2 - P_2h_2) + (3P_1h_1^2I_3/2bI_2)] \div \{1 + (6I_3/b)[(h_1/I_2) + (b/6I_1)]\} \quad \ldots\ldots (37)$$

For M_b, see Equ. 4.

From Equ. 15,

$$M_c = \tfrac{1}{2}(P_1 - P_2)h_2 \quad \ldots\ldots (38)$$

And, as previously, $x_1 = 2M_a/P_1$.

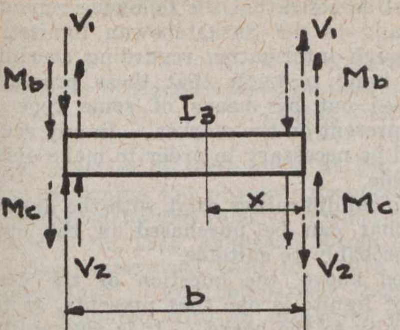

FIG. 4

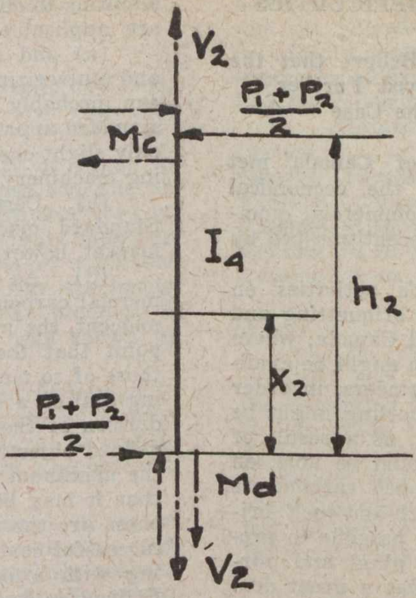

FIG. 5

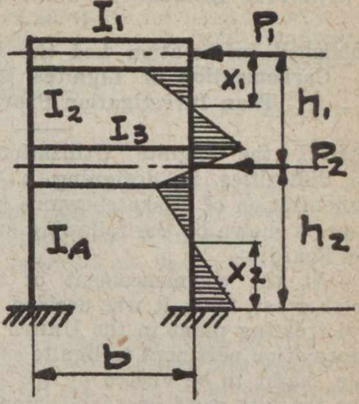

FIG. 6

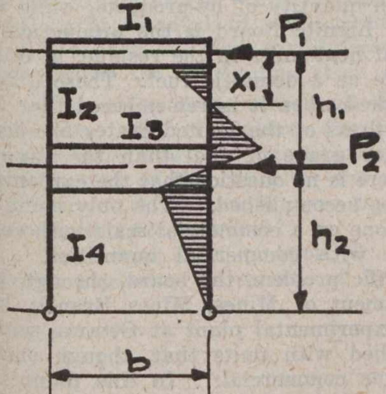

FIG. 7

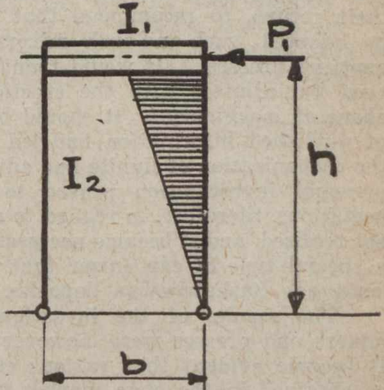

FIG. 9

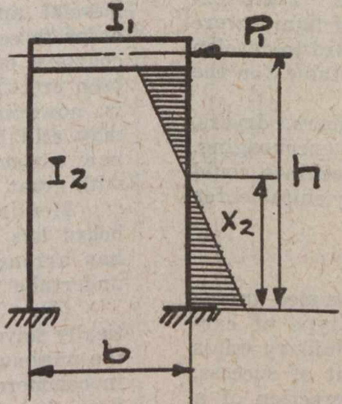

FIG. 8

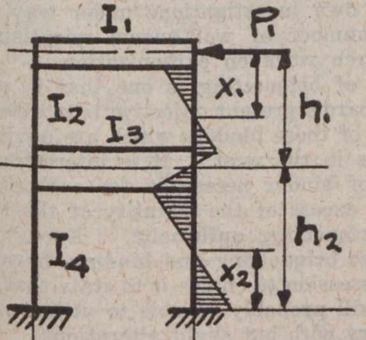

FIG. 10

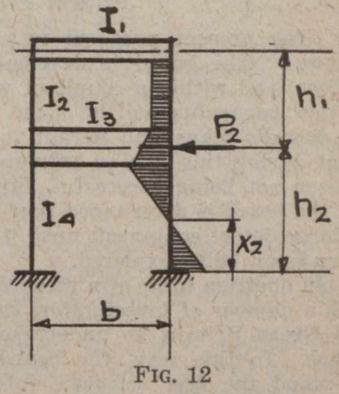

FIG. 12

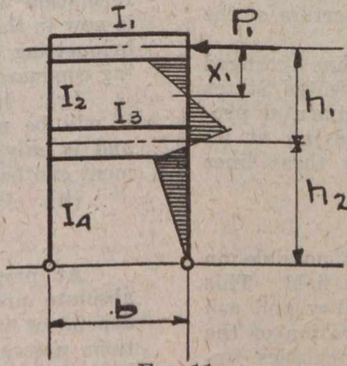

FIG. 11

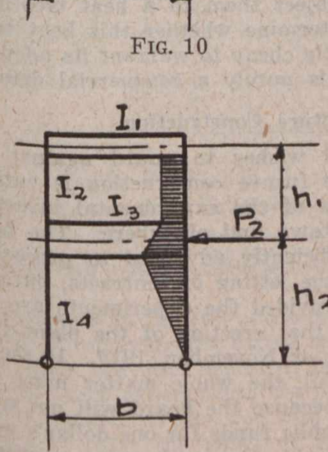

FIG. 13

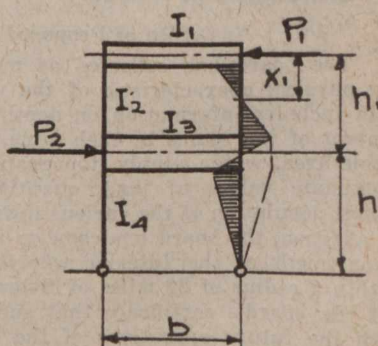

FIG. 15

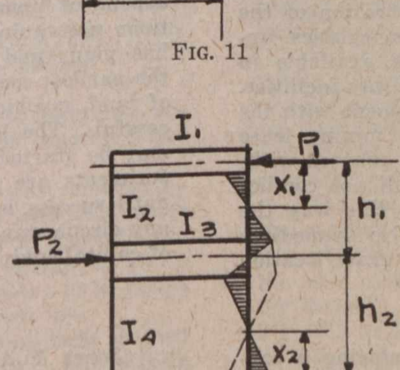

FIG. 14

DIAGRAMS ILLUSTRATING ARTICLE BY E. MAERKER, "FORMULAE FOR ONE-STORY AND TWO-STORY BENTS"

FIGS. 6 TO 15 ILLUSTRATE TEN DIFFERENT CASES—ANALYSIS BASED UPON ELASTIC THEORY OF STRUCTURES

LIGNITE BOARD ENCOUNTERED DIFFICULTIES

Published Information Led the Board to Believe that the Carbonization of Lignites Had Advanced Further Than Investigation Proved to be the Case

THAT the Lignite Utilization Board of Canada met difficulties in designing a plant for the economical carbonization of Saskatchewan's lignite in commercial quantities, is shown by the following statement recently issued by the Board:—

At the commencement of the Board's activities on October 1st, 1918, it was decided that every briquetting and coal treating plant in the United States and Canada, where information pertinent to lignite carbonization might be available, ought to be visited by the board's engineers, in order that the last word on carbonizing and briquetting might be obtained. At that time it was hoped that, as a result of this investigation, the board's engineers would be able, on their return, to recommend that such-and-such carbonizers be adopted, such-and-such mixers, and such-and-such briquetting presses. It would then have been possible to proceed immediately with the erection of the plant and purchase of machinery. It should be noted that a great deal of published information had led the board to believe that the carbonization of lignite had advanced further than actual personal investigation proved to be the case. Their expectations, therefore, in regard to carbonizing of lignite were not realized, and it became necessary for the board to develop a special type of carbonizer that might be suitable for the low-grade Saskatchewan deposits.

The results of the investigation of crushers, dryers, mixers and presses were, however, much more encouraging. It became evident that various commercial machines could be obtained in the open market that would be suitable for the board's needs with but slight alterations.

Present Program

The present program may be briefly summed up as follows: The board is developing a special type of carbonizer, and within a couple of weeks the preliminary trials of this apparatus will be made. In the event of success, the board's plans will permit it to start the erection of a plant during this coming autumn. In the event of this carbonizer not being successful, further designs will be made, but the board is determined that not one dollar will be spent on large retort equipment until it is absolutely certain of the ground now being explored.

In addition to its own researches, the board has arranged with a number of investigators in Canada, the United States and Great Britain, to undertake certain experimental programs. In this way, the board is sure of having at its command the best scientific information along these lines that can possibly be secured.

Site of Proposed Plant

The board has collected as much data as possible on the physical characteristic of the whole Souris field. This data includes information on depth, width, quality and ash content of the seams in each mine, the stratification of the whole area, water supply, topographical characteristics, approximate values of land, quantity of slack available in mines, population of the various towns, and railway facilities. In addition, the board has come to an arrangement with the Department of the Interior whereby no new mining lease within a radius of 20 miles of Estevan will be granted without the board's certificate that such lease will not conflict with the future operations of the board. In this way the interests of the public are safeguarded. No immediate decision, however, will be announced as to the exact location of the proposed plant.

Difficulties of Board's Program

The main divisions of the process of producing a carbonized and briquetted domestic fuel from raw lignite are as follows: (a) Crushing, (b) drying, (c) pulverizing, (d) carbonizing, (e) mixing, (f) briquetting, (g) water-proofing, and (h) cooling. These steps will be discussed briefly, in order that it may be clearly seen what the board is attempting to do. It must be noted that the following remarks are applicable specifically to the Saskatchewan lignites.

(a) and (c). Enough information regarding crushing and pulverizing is at hand to know that these processes can probably be carried out by means of some type of standard apparatus at present on the market. In any event only slight changes will be necessary in order to make existing machinery practicable.

(b). Certain technical difficulties exist with the drying. Standard machinery that can be purchased in the open market, however, will probably be suitable.

(d). As mentioned above, the question of the commercial carbonization of lignite is one that presents, at the moment, the most difficulty to the board. It is also at this point that the board's objectives differ most widely from those of so many firms in the United States that are retorting coal on a large scale. The latter have in mind the production of the maximum quantity of by-products, while the defined objective of the Lignite Board is the production of the maximum number of heat units in the residue, in order that it may be available as a domestic fuel. These differences are the more marked when it is remembered that the successful coal-treating firms of the United States are dealing with a much higher grade of fuel than the Lignite Utilization Board. There is no question that the carbonization of the lignite *can* be accomplished. The only point is, how cheaply can it be done on a commercial scale with commercial apparatus and with commercial quantities. In order to solve this specific problem, the board, through the courtesy of the Department of Mines, Mines Branch, has been erecting a small experimental plant at Ottawa, which is, however, to be suplied with units that, though small, may still be regarded as commercial. In this plant the new carbonizer is one toward which the board is looking with great hopes.

Mention has already been made of the fact that the board has not only its own investigations under way, but has arranged with a number of well-known scientists to undertake special research work on carbonization.

(f). The question of briquetting is one that is practically solved, and the board's present objective is to discover the minimum quantities of those binders which are available in commercial quantities in the west. It is interesting to note that the amount of binder necessary for carbonizing lignite is very much in excess of the quantity of the same binder necessary for briquetting anthracite. Enough information with regard to briquetting and binding, however, is now in the board's possession to enable it to state that, for briquetting presses, it will probably be able to utilize existing commercial machinery with but slight alterations.

(g). In order that the briquettes may be smokeless, it will be necessary to subject them to a heat treatment, and it only remains to determine whether this heat treatment can be made sufficiently cheap to warrant its adoption.

(h). Cooling. This is purely a commercial detail.

Probable Future Construction

At present the board wishes to guard against any absolute promises, because future construction is entirely dependent upon the results of the experimental investigations now going on at Ottawa and elsewhere. The board has plans and layouts sufficiently advanced to proceed at the earliest moment with the letting of contracts, purchase of land, machinery, etc., provided the experiments are successful. The board hopes that erection of the plant itself may be started by October or November, 1919. If the experiments are not successful, the whole matter must wait until success is achieved, because the board will not under any circumstances spend public funds for one dollar's worth of capital equipment that might afterwards prove unsuitable.

Jones & Attwood, Ltd., of Stourbridge, Eng., who are the owners of the patents on the activated sludge method of sewage disposal, and who have been the pioneers in its development in England, are transferring the activated sludge department of their business to a newly-formed firm, Activated Sludge, Limited, of Stourbridge.

EFFECT OF RODDING CONCRETE

By F. E. Giesecke
Professor of Architectural Engineering, University of Texas, Austin, Tex.

In a series of tests made at the University of Texas to determine the physical properties of dense concrete as determined by the relative quantity of cement, described in Bulletin No. 1815, published March 10th, 1918, only sufficient mixing water was used to secure a concrete of workable consistency. For comparison, however, a few specimens were prepared with an excess of water, which produced a very considerable reduction in strength, as was shown in Fig. 8 of the above-mentioned bulletin.

In practical operation it is almost absolutely necessary to use enough excess water to make the concrete sufficiently fluid to be handled in wheel-barrows, carriages or tubes, and so that it will flow readily into the forms and between and around the reinforcing steel.

With these facts before us—that an excess of water must be used to place the concrete correctly and economically, and that this excess water materially reduces the strength of the concrete—the question naturally arises, what, if anything, can be done to repair the injury that is done by the excess water?

To answer this question, G. A. Parkinson, assistant testing engineer, University of Texas, made a number of

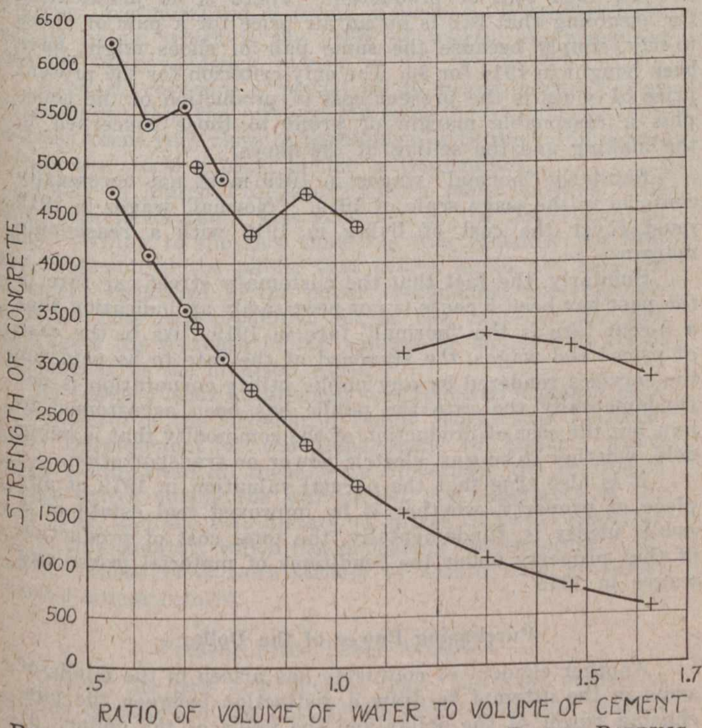

Fig. 1—Increase of Strength of Concrete Due to Rodding

Curve Shows Theoretical Strengths Calculated from Prof. Abrams' Cement-Water Formula (Assuming the Constants as 7 and 14,000), While Broken Lines Show Tested Strengths of Same Concrete after Roddings.

experiments in the fall and winter of 1917, to determine the effect of removing the excess water from the concrete after the latter had been deposited in the forms.

In these experiments the excess water was removed by forcing a pointed iron rod into the concrete while the latter was still soft; the effect of running such a rod into the concrete is to permit the excess water and entrapped air to escape upward, and to compact the aggregate; as a result the density of the concrete is increased about 4%.

This method of treating concrete has been named "rodding"; it is quite similar to "spading," but differs materially from "tamping." The results of Mr. Parkinson's early work were so very satisfactory that an extended series of tests was begun in June, 1918, and this was followed by other series of tests as new phases of this method of treating concrete developed. Some of these tests are still incomplete; but considerable important data have been secured and the following will be of interest.

Fig. 2 shows graphically the ultimate unit compressive strengths of fifty-four 6 by 12-in. cylinders. The concrete had the following composition:—

Material.	Percentage.
Cement	14.40
Passing 35-mesh sieve	4.35
Passing 12-mesh sieve and retained on 35-mesh sieve	9.00
Passing ¼-in. sieve and retained on 12-mesh sieve	13.00
Passing ¾-in. sieve and retained on ¼-in. sieve	29.50
Passing 1¼-in. sieve and retained on ¾-in. sieve	29.75
	100.00
Water	10.00

The 54 cylinders were divided into three groups of 18 cylinders each. In each group one cylinder was not rodded; the remaining 17 were rodded from one to seventeen times. In one group a 10-min. interval was allowed between roddings; in another a 20-min. interval; and in the third group, a 30-min. interval. The first rodding was applied soon after the moulds were filled; i.e., without waiting for the full interval of time assigned the particular series to pass. By one rodding is to be understood the pushing of a pointed

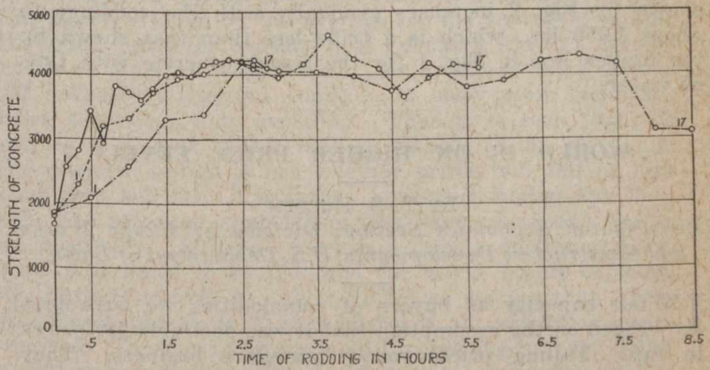

Fig. 2—Variation in the Increase of Strength of Concrete, Due to Rodding, with the Number of Roddings

iron rod into the concrete to the full depth of the concrete once for every surface area of about 3 sq. ins.; i.e., about ten times for a 6-in. cylinder.

It is interesting to note:—

(a)—That the maximum strength is about 130% more than that of the unrodded specimens.

(b)—That all three series acquired their maximum strength in about 2 or 2½ hrs.

(c)—That for the 30-min. interval it required 5 roddings; for the 20-min. interval, 7 roddings; and for the 10-min. interval, 14 roddings, to secure the maximum strength.

It is probable that the length of time and the number of roddings necessary to secure the maximum strength vary with the temperature and with the percentages of cement and water.

Fig. 1 shows graphically by the broken lines the average ultimate unit compressive strengths of thirty-six 6 by 12-in. cylinders arranged in twelve groups of three cylinders each.

The intermediate group, represented by crosses within circles, was made of concrete having the same composition as that represented in Fig. 2; but the mixing water was 7% for three cylinders, 8% for three, 9% for three, and 10% for three. This concrete contains cement at the rate of about six sacks of cement per cubic yard of concrete.

The two other groups are of similar composition, but the cement content changed to about four and eight sacks respectively per cubic yard. The percentages of water for the lean mixes were the same as for the intermediate, but for the rich mixes they were increased, respectively, to 7½, 8½, 9½ and 10½%.

To compare these results with the strength of plain concrete, the work of the Lewis Institute, of Chicago, as reported by Prof. Abrams, was selected as being probably the latest and most reliable, and probably also the most appropriate, since it gave special attention to the effect of excess water on the strength of the resulting concrete.

According to the Lewis Institute tests the strength of concrete is a function of the ratio of the volumes of water to that of the cement used in the production of the concrete, and is 14,000 ÷ 7^R lbs. per sq. in. for cement 28 days old, R being the ratio referred to, and the weight of one cubic foot of cement being assumed as 94 lbs. The curved line shows the strength of the twelve groups of specimens as calculated by this formula.

An inspection of Fig. 1 shows:—

(1)—That the effect of rodding concrete is more beneficial with lean than with rich mixes, and that it is more beneficial with wet than with dry mixes.

(2)—That the average strength of 8-sack concrete can be increased about 45% by rodding; that of 6-sack, about 60%; and that of 4-sack, about 220%.

To appreciate how well the values shown in Fig. 2 (determined by test July 11th, 1919) check with those shown by the broken line in Fig. 1 (determined by test March 19th, 1919) and with those shown by the curved line in Fig. 1 (calculated from the Lewis Institute formula), notice that the average strength of the unrodded specimens shown in Fig. 2 is about 1,800 lbs., and that this is almost exactly the same as that shown by the curved line in Fig. 1 for the 6-sack concrete with 10% of water; also that the strength shown by Fig. 2 increases gradually with the roddings to about 4,250 lbs., which is a trifle less than that shown by the broken line in Fig. 1 for the 6-sack concrete with 10% of water.

WORLD IS ON HIGHER PRICE LEVEL*

By T. S. Holden

Investigator Economics Section, Division of Public Works and Constructive Developments, U.S. Department of Labor

In our capacity as buyers of commodities we have proceeded on the assumption that it was desirable for prices to fall. Falling prices rarely stimulate business. They usually stimulate waiting for further declines. A period of falling prices is usually a period of business depression. The past six months has been remarkable for the small number of business failures. It is entirely possible that a sharp decline in prices might have been accompanied by a greater number of business failures than there has been, attended with a much greater menace of unemployment. A financial panic might have been within the bounds of possibility.

Many of those who have been deferring building projects and the resumption of production of commodities have stated that they were waiting until prices and wages should have returned to "normal." The word "normal" has been used extensively in this connection and most of those who have used it have not appreciated the true meaning of the word. Not only in connection with prices and wages has this term been used incorrectly, but courts and public utility commissions have used the term loosely when speaking of valuations of properties. It is worth while to determine just what this word means in connection with prices, wages and property values, not in the interest of academic precision but simply to aid clear thinking on this subject.

A paper entitled "Appraisals and Rate Making" was read March 20th at the annual meeting of the Illinois Gas Association by Cecil F. Elmes, an eminent engineer. In this paper Mr. Elmes presented with the utmost clarity and force, certain aspects of the price situation as affecting valuations of public utility properties and the principles of rate making. In the course of his discussion Mr. Elmes dwelt at some length on the misconception of the term "normal." He presented curves showing the fluctuations of prices in England on five basic articles, wheat, iron, lead, cattle and sheep, covering a period of six centuries. He also presented curves showing fluctuations of artisans' wages, both in terms of money and in terms of the quantity of wheat the wages would buy, covering the same extended period. He pointed out that in the case of each one of these curves the fluctuations are so erratic that it is impossible to draw a horizontal straight line, an oblique straight line, or a mathematical curve which could in any sense serve as a median about which the prices or wages fluctuate. Consequently, it is not possible to define mathematically in terms of past experience the "normal" price of a given commodity, or "normal" wages. Neither is it possible to thus define a "normal" rate of increase in prices or wages.

Not everyone has the opportunity to consult the records of the British museum, as Mr. Elmes has had, for the purpose of studying this subject. There is, however, another authority which is readily accessible to all, Webster's Dictionary. Webster defines the term in connection with economics as follows:—

"Pertaining or conforming to a more or less permanent standard, from which, if the individual phenomena deviate on either side, such deviations are to be regarded as self-corrective. Thus, in economics, the normal price is a price which corresponds to the cost of production."

Relation of Price and Cost

The standard to which a price must conform is, therefore, not necessarily a price that we are accustomed to, or that we were accustomed to five years ago. Mr. Elmes has shown that past experience has established no mathematical standard to which a price may be expected to conform. Webster says that the standard is the cost of production. In 1919 the standard is the cost of production in 1919, and not the 1914 cost of production. There is no justification for assuming that $12 is an unfair price for a pair of shoes to-day, simply because the same pair of shoes might have been bought in 1914 for $6. The only criterion for the present price of shoes is the present cost of production of the shoes plus a reasonable margin of profit to those concerned in the making and the selling of the shoes.

Similarly "normal" wages in 1919 must not necessarily conform to the wage scale of 1914. "Normal" wages in 1919 must cover the cost of living in 1919 with a reasonable margin.

Similarly, the fact that the customary street car fare in the past has been 5 cents is not necessarily an indication that a 5-cent fare is the "normal" fare in 1919. As in the case of prices and wages, the standard of the rate to be paid for the services rendered by any public utility corporation is not fundamentally the rate the public has been accustomed to pay, but the cost of production of the commodity that is being sold, whether it be gas, electric power or transportation.

It is also true that the normal valuation in 1919 of any piece of property, whether it be improved real estate or a public utility is, fundamentally, the total cost of production of that property under the conditions of material prices and wages in 1919.

Purchasing Power of the Dollar

Another element of confusion has arisen in the minds of some in the attempt to draw a distinction between the purchasing power of the dollar and the value of the dollar. It has been stated that the purchasing power of the dollar measured in commodity prices has been cut in half, but the value of the dollar, which should be measured in terms of the wealth of the country, consisting of real and personal property, has not risen. On the basis of this distinction it was argued that prices must fall in order that the purchasing power of the dollar might become commensurate with the value of the dollar. It appears to be an economic fallacy to draw such a distinction. John Stuart Mill defines values as follows:—

"The value of a thing is its general power of purchase, the command which its possession gives over purchasable commodities in general."

In other words, the value of the dollar is the purchasing power of the dollar. Furthermore, contrary to the argument outlined above, prices have remained high and rents and property valuations have been increasing since the time the statement referred to above was made.

The owner of a house and lot may state to the tax assessor that the value of his property is $10,000. In making a

*Abstract of prepared testimony submitted to the Public Utilities Committee of the Chamber of Commerce of the United States.

statement of his assets and liabilties for the purpose of securing credit he may place the value of his property at $15,000. In his own mind he realizes that these valuations are more or less fictitious, though perhaps justified by custom. However, if he knows that the price which he can get for the property is $12,000, he knows that the actual value of the property is $12,000.

In connection with valuations of public utilities and the fixing of rates, although the basic principle which applies to the price of commodities and wages of labor and valuation of real estate constitutes the standard of normality, it is fully realized that, in practice, restrictions, legal and otherwise, operate to modify the application of this principle. However, it is evident to all that so long as these properties are owned and operated by private interests the return must ultimately be in proportion to the cost of production of that which is sold to the public. When operated by the public through government officials, if the rates paid for the service are not sufficient to cover the costs, the deficit has to be paid out of public funds.

It has been pointed out above that the curve for the fluctuation of prices of any particular commodity covering a long period of years, is so erratic that it is impossible to define from it either a "normal" price of the commodity or a "normal" rate of increase in price. However, if the curve representing the average of prices of a great number of basic commodities be drawn, the fluctuations are much less marked than those of any particular commodity.

Prices and productions costs, which constitute the norm of prices, are measured in terms of money. Wages and the cost of living, which is the norm of wages, are measured with the same yardstick, money.

A chart, covering a period of 46 years in the United States, shows that the curve of the price index for basic commodities keeps very close to parallelism with the curve representing the stock of legal tender in the country.

Early in March Professor Fisher's paper entitled "The New Price Revolution," was published by the Department of Labor. Owing to the fact that this was probably the first announcement to the public that prices would not fall, the statement contained in the paper commanded universal attention. This paper pointed out as the cause of the new price level the increase in the amount of money and credit instruments in the civilized world.

Professor Fisher's statement was followed a month later by a bulletin of the Division of Public Works and Construction, "Development of the Department of Labor," which briefly summarized all those facts concerning the records of foreign prices during the war period, the experience of the Civil War, and the war history of prices of basic commodities in this country, which had a bearing on the present situation. These facts were strictly in accord with Professor Fisher's announcement.

Present Price Level Accepted

During the past few months there has been evident a growing tendency on the part of the public to accept present prices and to wait further only for some assurance that prices would not fall.

The investigating committee appointed by the Illinois State Legislature in its report published May 6th, stated definitely that all the facts it had learned concerning wages and production costs and prices were in accord with the theory that a new price level had been established. As evidence of its complete acceptance of this fact, the legislature immediately authorized the letting of contracts for 650 miles of roads.

The growing volume of building operations throughout the country indicates that the public has largely given over its policy of waiting. The Department of Labor is daily in receipt of statements from leaders in business and finance attesting the correctness of the statements it has published concerning prices.

The Federal Reserve Bulletin for May states:—

"The underlying and most general factor tending to sustain the present high level of values is the credit and banking situation inflated as it is throughout the world. So long as the condition of inflation referred to continues to exist as at present, it must be expected that reductions of price will occur slowly as a result of changes in the demand for and supply of commodities. This will in some cases bring about reductions in the levels of values, but in others will produce corresponding and offsetting variations in the opposite direction. Prices will thus be subject to temporary oscillations, but in order to bring about any broad and far-reaching readjustment affecting the relationship of all commodities to the unit of purchasing power, inflated credit conditions must be eliminated, and the business community must be placed upon practically the footing in relation to credit and money which it is normally to occupy."

One of the factors that has tended to delay building operations has been the tendency on the part of bankers to refuse advances of money on the basis of valuations computed in terms of present prices of materials. It is hoped that the statement of the Federal Reserve Board will influence the bankers to pursue a more liberal policy.

Maximum Level Not Yet Reached

According to figures of the Bureau of Labor Statistics, the maximum level of wholesale prices of basic commodities was reached in September, 1918, the index figure being 207. This figure is based on the average for the year 1913 as 100. The index figure for the month of February was 197, for the month of March it was 200, for the month of April it was 203. Weekly quotations continue to show more commodidities advancing than declining. Thus it is seen that the price level is again within hailing distance of the maximum. The question to-day is not whether prices will fall or how much they will fall; it is rather, how much higher will they go? The principal commodities that have advanced recently are foodstuffs. Although there is a surplus in this country, there is a world to be fed; and the world supply is short. Mr. Herbert Hoover has been quoted as stating that wheat would probably go to $3.50 a bushel if all restrictions were removed. The cost of living is still increasing and the dollar is still on the decline. The problem is to arrest this decline in the purchasing power of the dollar.

People want to know to-day what future prices are likely to be. It is impossible to prophesy, but it is possible to view facts that will have a bearing on future prices. From these facts it may be possible to indicate future price tendencies.

It took 13 years after the Civil War for wholesale prices to get back to the pre-war level. The circumstances of that period were much more favorable for price reductions than they appear to be at the present time. As compared with the war just ended the Civil War was a purely local affair.

The reason why the present situation has been so difficult to understand is the fact that it is a world-wide phenomenon. The scope of the economic changes has been as wide as the war itself. In January of this year the Bureau of Labor Statistics' index figure for wholesale prices of all commodities showed an increase of 102 per cent. over the year 1913. At the same time the price level in England was 117 per cent. higher than in 1913; in France it was 249 per cent. higher. It is a significant fact that France, which showed such a marked rise in the price level, resorted to inflation to a much greater extent than did either England or the United States. In England and in America it has been considered wise to pay a large proportion of the expenses of the war through the levying of heavy taxes, thus minimizing the necessity for extension of the public debt and the inflation of currency. In those countries where it was considered expedient to avoid high taxation and to resort to inflation, the people are now paying the piper through the high prices they are obliged to give for the necessities of life.

Whether you believe with the majority of economists that the price level is the result of the amount of money, or whether you agree with the minority that the quantity of money accommodates itself to the price level, the present condition of world-wide high prices accompanied by a worldwide increase of money and credits, must be considered. Either prices in the future will be less because of a contraction in the amount of legal tender, or lower prices in the future must be accompanied by a decrease in the amount of legal tender. Hence the problem of future prices depends upon the solution of the financial problems and a solution of that can not be wholly controlled by any one country.

Lord D'Abernon, an eminent British financier, has been quoted as follows:—

"If there were to be any attempt to-day to bring about a rapid return to the gold currency basis of 1914 it would almost double the weight of the world's indebtedness and would certainly lead to the bankruptcy of many nations. The governments which have borrowed cheap money would, in the case of contraction, have to repay with dear money. Individuals who have borrowed cheap money would have to pay back with dear money. It is extremely unlikely that the governments of the world can be reasonably expected to decrease appreciably the world inflation within a brief period of years."

Condition Not to be Avoided

The conditions that have brought about inflation and the rise in the price level in this country could only have been avoided if all trade relations with Europe had ceased at the outbreak of the war. What has happened has been that we have shipped enormous quantities of goods to Europe. These goods have not been used in production, but have been consumed or destroyed. We have received in return, not goods, but money. These transactions, in the aggregate, have approximated $15,000,000,000. Before the war this nation was indebted to Europe to the extent of $6,000,000,000. We are now Europe's creditor to the extent of $9,000,000,000.

A serious problem at the present time is concerned with the conditions surrounding future trade relations with foreign countries. If America continues to ship goods to Europe, receiving in return only money or promises to pay, there is danger that the disparity between the amount of commodities and the amount of money in this country will continue to grow, resulting in a level of prices even higher than that obtaining at the present time. In view of this, some people think to-day that it may become advisable to restrict exports to such an extent that they may be paid for in commodities rather than in money. Such a regulation could scarcely be put into effect all at once. It might not be practical at all. It would appear, however, that Europe's debt to us must ultimately be paid in goods.

Any consideration of future prices must necessarily involve a consideration of the probable tariff program. Without going into the controversial aspects of this subject, it is well that these phases of it which are likely to affect prices be noticed here. It is a serious question whether it is desirable that a tariff schedule be framed in such a way that we shall continue to ship goods away and receive in return only money or promises to pay. What used to be considered a favorable balance of trade, may not be considered so favorable in the future. The ideal condition in foreign trade is the exchange of commodities for commodiites, money being used merely as that which facilitates the exchange. It is true that it would not be desirable to have foreign goods sold in this country in such a way as to demoralize our markets. It is none the less true that we do not want further increases in our stock of money to such an extent that its purchasing power will continue to decline.

A Serious Problem

This problem is engaging the serious attention of some of the best informed leaders in business, economics and statecraft. It is to be hoped that their reasoned opinions will have a great influence on our future tariff policy. Even though past tariff policies may have been successful, any new policy must be framed after thorough consideration of a large body of new facts. A wise program can not be expected if it is made solely as a compromise between the claims of short-sighted, selfish interests. It can not be expected if the problem is viewed only in the light of before the war.

There are many far-sighted, thoughtful men among our leaders of business and our public men. There are men expert in this intricate subject among our practical economists. It is to be hoped that the ideas of these groups will prevail.

Although foreign trade relations have been so largely responsible for the conditions we face at present, and though these relations may be of great importance in the future, it is possible to concentrate too much upon the problems they involve. These problems can not be settled at once. France has been obliged to await the settlement of the Peace Treaty, and has deemed it expedient to place drastic restrictions on imports during the waiting period. Great Britain has raised the barriers against foreign goods for the duration of such time as is necessary to get her industrial house in order. The period of readjustment in Europe must be necessarily prolonged.

In the meantime, should the people of the United States sit idly by and watch their dollars shrink? Must prosperity wait until foreign markets are opened to us? When the wheels of American industry are turning and every able-bodied worker has a job that brings him a substantial wage, there is a pretty extensive market for American goods among the 110,000,000 people of America. The best way for Americans to set about arresting the shrinkage of the dollar is to produce more goods, thus remedying the existing disparity between commodities and money.

Prices of Building Materials

The shortage in the United States has been estimated at 1,000,000 houses.

At the beginning of the year the building of homes was urged on the grounds of patriotism. At present, it is an absolute necessity that they be built to fill an urgent need. Furthermore, in the light of present information concerning prices, it can be shown that money spent on building is money well invested.

Considered in relation to prices prevailing in the year preceding July, 1914, building materials are cheaper now than most other commodities. By the end of 1918 lumber had advanced 73 per cent. above the pre-war level; mill prices on Portland cement had risen, on the average, 74 per cent.; f.o.b. plant prices on mineral aggregate (sand, gravel and crushed stone) had risen, on the average, 73 per cent.; building stone, on the average, 64 per cent.; common brick, 92 per cent. The building materials group (not including any metal products) rose 84 per cent. Compare this with a rise of 113 per cent. in all other commodities, and with a rise of 116 per cent. in the group of farm products. The cost of construction of buildings on the average has increased about 62 per cent.

Little evidence is in sight pointing to a decline of prices in general. There is even less likelihood of declines in prices of building materials. The index for the group was the same for the first quarter of this year as for the last quarter of 1918. Slight declines in some materials have been offset by slight advances in others. As a group the prices have been practically stabilized.

In the nature of things, prices of building materials fluctuate less than the prices of those commodities which are consumed from day to day, such as foodstuffs and textiles, and of those commodities such as the metals, which furnish the raw materials of industry. During the Civil War building materials advanced less rapidly than did other commodities and they failed to reach the high levels of other commodities. In fact they remained above the general level of all commodities until 1874. If building materials, instead of fluctuating in price, had declined from the high point of January, 1865, at a uniform rate of 4 per cent. per annum until 1874, they would have reached their actual 1874 level, which was the general level of all commodities for that year.

Not Likely to Decline

A decline of 4 per cent. per annum in prices of materials would probably not involve an annual depreciation in value of a building of more than 2½ per cent. The fact is that present conditions do not indicate that the next few years will see declines in building material prices amounting to as much as four per cent. a year. It is more than likely that building materials, on the average will not decline at all for a considerable period. Present indications are that building

(Concluded on page 41)

FLAT RATE vs. METERS*

Comparison Between Operating Conditions Under the Two Methods of Charging for Water Consumed—Flat-Rate System Unjust to Consumers—Meters Profitable

By C. E. Abbott
Water Works Superintendent, Tuscaloosa, Ala.

THERE has always been some controversy as to the relative merits of conducting water works systems on a flat-rate basis and an all-meter basis, with conditions otherwise the same, and as to whether the benefits to be derived warrant the installation of the all-meter system. The owners and operators are practically unanimous in support of the meter system, while the consumers uniformly contend for the flat-rate basis; and this fact alone tends to show upon whose side the benefits of the meter system lie.

Of course, no criterion can be established for the entire country from statistics gathered in any one locality and, furthermore, it would be foolish for any one man to undertake from his own experience to prescribe the best operating methods for localities other than his own and operating under conditions with which he is not familiar. I have been manager of the water works system at Tuscaloosa, Ala., for about eight years. During this time the plant there has been operated first upon a flat-rate basis and later upon a practically all-meter basis, and I am therefore in position to give facts and figures by a comparison of which the many advantages of the meter system can be easily seen. However, I certainly do not wish to be regarded in the light of trying to tell other managers and superintendents how to run their business, or to insinuate that I know it all, or any more than any one else; but, having operated my plant under both systems and had opportunity to observe carefully the results of both operations, it has occurred to me that probably the figures covering these operations might be of interest to other operators who perhaps at this time find themselves under similar conditions as we were when we contemplated the change from the flat-rate basis to the meter basis.

From the Operator's Viewpoint

There are many advantages of the meter system over the flat-rate system that need no comparison to establish their validity. One of the foremost of these is the great injustice, to the consumers themselves, of the flat-rate system. Upon this slack basis one consumer may pay a stipulated amount for his water—based probably upon the number of openings—and probably use 5,000 cubic feet of water within a given time; while another consumer, with the same number of openings and paying the same basic amount for his water, could use 10,000 cubic feet of water within the same time and with no additional cost.

However, being a manager of a plant, of course, I am concerned chiefly with the operator's side of the matter, and it is the benefits and advantages to be derived by the operator himself that I propose to show in making a comparison of the statistics set out herewith, representing the operation of our plant first upon a flat-rate basis and latter upon a meter basis. Of course, the points of greatest concern to the operator are: Increasing the general efficiency of his plant, cutting down the amount of water to be pumped, cutting down the amount of fuel consumed—with the consequent decrease in operating expense—and increasing the revenue.

In 1911 the plant of which I am manager was operating upon a flat-rate basis. We commenced installing meters in the fall of 1913, with the idea of metering the entire system, which was practically completed in 1915. Beginning with the year 1916 the plant was operating upon practically an all-meter basis. Therefore, by a comparison of the statistics covering the operation during these two years, the effect of the installation of the meter system can be shown; and by this comparison I propose to show how the amount of water pumped per day in 1911 under the flat-rate basis was decreased in 1916 under the meter basis by about 27%, notwithstanding the fact that there was an increase in the number of consumers in 1916 of about 65%, and how the amount of coal consumed in 1911 was decreased by about 170% in 1916, and the operating cost decreased proportionately.

*Excerpts from a paper read before the annual convention of the American Water Works Association at Buffalo.

Operating Conditions in 1911

The general conditions under which the plant was operated in 1911, and the equipment, were as follows:—

The power plant is situated upon the banks of the Warrior River, about three miles above the city of Tuscaloosa, Ala. The plant is situated upon an incline—the settling basin being above the plant and the water flowing by gravity through slow sand filters to the clear-water basin below the plant. The water was pumped from this clear-water basin to a stand-pipe in the city—the tank having a capacity of 125,000 gals. and an elevation of 100 ft. The pumps were operated twenty-four hours a day, working against a pressure of 165 lbs. at the plant. The actual equipment consisted of three 72-in. by 16-ft. return tubular boilers; two horizontal compound, non-condensing Worthington pumps—alternating in operation weekly. The cylinders were:—High pressure, 16 ins.; low pressure, 25 ins.; water plungers, 11 ins.; stroke, 15 ins.; rated capacity, 24 gals. per stroke. The water pumped in 1911 is figured on the delivery of these pumps, allowing 10% for slippage.

The figures covering the operations during the year 1911 are as follows:—

Number of consumers at end of 1911:—	
Flat rate	927
Meter	42
Amount of water pumped during entire year	317,335,980
Average amount of water pumped daily	869,413
Number of tons of coal used during the year	3,285
Cost of coal $2 per ton.	

General Conditions in 1916

The general conditions under which the plant was operated in 1916, and the equipment, were as follows:—

The operating conditions in 1916 were the same as in 1911, with the exception that a new reservoir had been built within one-half mile of the power plant. It is 62 ft. high and 75 ft. in diameter, constructed of reinforced concrete. This reservoir was planned and built by Morris Knowles, of Pittsburgh, Pa., and is a magnificent piece of engineering work. Also a new high-service pumping engine was added: Type, Myer; gear flywheel; high pressure cylinder, 14 ins.; low pressure cylinder, 30 ins.; water plunger, 10¼ ins.; stroke, 24 ins.; condensing; rated capacity, 30 gals. per stroke; manufactured by Laidlaw Dunn Gordon Company. The amount of water pumped in 1916 is figured on the delivery of this pump, allowing 5% for slippage. The number of pumping hours was reduced in 1916 to an average of 10 hours per day.

The figures covering the operations during the year 1916 are as follows:—

Number of consumers at end of 1916:—	
Flat rate	190
Meter	1,414
Amount of water pumped during entire year	230,779,985
Average amount of water pumped daily	632,274
Number of tons of coal used during the year	1,215
Cost of coal $1.95 per ton.	

Comparisons, 1911 and 1916

Total number of consumers in 1911	969
Total number of consumers in 1916	1,604
Numerical increase in number of consumers	635
Representing an increase of 65% plus.	
Amount of water pumped during 1911	317,335,980
Amount of water pumped during 1916	230,779,985
Numerical decrease in gals. pumped	86,555,995
Representing a decrease of 27% plus.	
Number of tons of coal used during 1911	3,285
Number of tons of coal used during 1916	1,215
Numerical decrease in number of tons	2,070
Representing a decrease of 63% plus.	

All the above figures are taken from the records of the City Commission of Tuscaloosa, Ala., and can be verified upon inquiry.

Best Check on Operation

From a standpoint of efficiency, and in order to check the operations of the plant, it is essential that the operator account for, so far as is possible, all the water that is pumped; and it is unquestionable that the meter system provides the best method for this. However, notwithstanding all the benefits derived from the employment of meters, even where the meter system is employed, certain conditions arise in which it is not practicable to use meters. It will be noted that while employing the meter system almost entirely, we still have 190 consumers receiving water on a flat rate. This condition arises from the fact that these 190 consumers live outside the sewer zone and have each only one opening on the premises, and twenty meters placed on consumers under identically the same conditions show that 50% of the minimum allowed under the flat rate is never reached.

With the meter system in operation during the year 1916 we were enabled to account for 85.8% of all the water pumped during the year. These figures would be higher but for the fact that we had no way of accounting for the water used in fighting fires, and the amount used in street flushing, sprinkling, etc., is purely an estimate based upon the capacity of the tank, and the estimate is in fact considerably below the amount of water actually used for these purposes. The figures in substantiation of this are as follows:—

Where the Water was Used

Total meter reading for domestic consumers ..	114,186,477
Total meter reading for mannufacturers, etc. ...	59,144,425
Total meter reading for filter wash water	9,552,660
Total meter reading for schools	2,920,460
Estimated amount used in street sprinkling, etc.	11,182,000
Total amount of water accounted for by records	196,986,022
Total amount of water pumped during year ..	230,779,985
Water unaccounted for	33,793,963

Representing a percentage of only 14.2% of the total amount pumped as being unaccounted for.

Lockwood, Greene & Co. of Canada, Ltd., industrial engineers, have opened an office in Montreal. E. G. Horne, formerly of Grant & Horne, contractors, of St. John, N.B., is the manager. The head office of the parent company, Lockwood, Greene & Co., is in Boston.

The Association of Canadian Building and Construction Industries called a meeting of its national council to be held last Monday in Ottawa in order to meet representatives of the government and of organized labor, for a general discussion of the labor situation. About seventy-five labor delegates and approximately an equal number of employers were expected to be in attendance.

The question of a general sewerage system for the municipalities of St. Lambert, Lougueuil, Greenfield Park and Montreal South, has been before the Quebec Public Utilities Commission. Messrs. Lea and Duchastel, engineers appointed to prepare plans, reported that there was a difference of opinion between the municipalities as to the location of the outlet and the engineers recommended that it be placed about 1,600 ft. out in the river, just below the government wharf, at a point known as St. Antoine's Creek. F. W. Cowie, engineer for the Harbor Commission, objected to this location on the ground that it might interfere with the future plans of the Commission, and that the situation is one where the outlet would be menaced by ice. Objections to the site proposed were also made by representatives of the municipalities interested. The engineers were instructed to continue making tests as to the current and ice conditions, whether the outlet should be temporary or permanent, and also as to whether it would be advisable to construct the sewer of greater strength than was at first proposed.

BOND PREMIUMS ON GOVERNMENT CONTRACTS*

THE form of "cost-plus" contract used by the construction division of the United States War Department during the war provided under the heading of "Cost of Work" for reimbursement of the contractor's actual net expenditures. Among the various items was the following:

"(h) Such bonds, fire, public liability, employer's liability, workmen's compensation and other insurance as the contracting officer may approve or require."

Article IX. provided that:

"The contractor shall, prior to commencing said work, furnish a bond with sureties satisfactory to the contracting officer."

Notwithstanding these provisions, the comptroller of the treasury has recently held that the form of cost-plus contract in use by the construction division does not authorize the reimbursement to contractors of the cost of premiums on their bonds. This ruling has been adhered to in the face of strong objections by the chiefs of the construction division.

Association Secures Legal Assistance

Upon inquiry of representatives of the construction division, it is ascertained that it is quite certain that all contractors having unsettled contracts for work under that division and money due them under such contracts will now have deducted from any balance due them the sum of all payments heretofore made to them covering reimbursement of premium on bonds. This will probably include not only their unsettled contracts but such payments made upon other contracts of this class upon which settlements have already been made. It is not possible to say whether those who have no current construction contracts will be called upon to refund all such sums heretofore reimbursed to them. This will depend upon the discretion of the disbursing officers of the war department and the orders of the accounting officers of the treasury.

This matter is one of wide importance to contractors and accordingly the officers of the Associated General Contractors of America have taken up the subject for conference with King & King, attorneys, Washington, D.C. As a result of very careful consideration, the following suggestions are made:—

If the amount of premium bonds already is deducted from moneys otherwise due upon current contracts, the contractors should accompany the voucher covering any such payment and showing such deduction with a letter containing substantially the following language:—

"It is to be understood that in accepting payment evidenced by the attached voucher under our contract of .... for constructing .... we do so without in any wise waiving our legal rights to full reimbursement under the terms of our contract of all sums paid by us as premium on bonds. We expressly reserve our rights to reimbursement of all sums paid by us on such account."

This letter should be pasted to the voucher.

Refuse Demands for Refunds

Those who are called upon to refund any payments of the kind noted should decline to do so abolutely and leave the government to take such action as it may deem advisable looking to a recovery.

The attorneys named have given us their opinion that the contracts entitle the contractors to reimbursement of these premiums, that the deduction is unlawful, and that it can be recovered by future proceedings in the treasury department or before the court of claims.

The opinion of the comptroller above referred to was given as an advance opinion to several disbursing officers. This will govern the action of all disbursing officers for the future, but it is not conclusive even in the comptroller's office. The matter can be brought before the comptroller again upon a claim duly presented by any contractor. This claim must be filed with the auditor for the war department and will

*A circular letter mailed to members of the Associated General Contractors of America.

be disallowed by him and then appealed to the comptroller. The comptroller will then hear legal argument upon the merits of the question. The opinion already rendered will be considered by him as prima facie correct, but he will not hold it to be finally binding upon him, if convinced to the contrary by any arguments then presented to him. There are numerous precedents for the comptroller reversing, in a claim thus brought before him, an advance opinion rendered to a disbursing officer.

Will Conduct Test Case

Should the comptroller decide this test case favorably, the other claims will be paid. If the comptroller adheres to his unfavorable decision, a test case can then be taken before the court of claims. If the court of claims decides in favor of the contractor in the test case, the comptroller will probably reverse his decision and allow other claims of the same nature, if they have not already been brought before him and adversely decided.

It is also possible to test this question by insisting upon a suit being brought against a contractor by the United States. It may be thought best to take this course, but at present it is thought best to make the test by a suit in the court claims.

It is not probable that any contractors will be pressed for payment of premiums already paid to them under settled contracts unless a decision should be rendered by the court of claims adverse to them. Such a result is not expected. If that is adverse, there will still be an opportunity for defense to such claims under the provision of Article IV. of the contract, providing that the monthly statement of costs and "all payments made thereon shall be final and binding upon both parties hereto."

Independent Action Not Desirable

This association expects to take up this matter as an association matter on behalf of the contractors interested. Nearly all of them are already members of the association and it is hoped that all others interested will join the association in order to bear their fair share of the movement. It is very important that contractors should leave the handling of this matter to the association, as independent action may interfere with the orderly handling of the test case in the manner above outlined.

ADVANCE IN BOOK PRICES

ANNOUNCEMENT is made, to take effect immediately, of an advance of $1.00 per volume in a number of $5.00 handbooks published by the McGraw-Hill Book Co., of New York City. The company states that the increase from $5.00 to $6.00 is necessitated by the steadily increasing cost of labor and materials.

Readers are also reminded that announcement was made recently by another very prominent New York publisher, John Wiley & Sons, Inc., that an increase in the prices of a number of their books would go into effect August 20th.

All orders received by *The Canadian Engineer's Book Department* for McGraw-Hill books will now have to be at the new schedule of prices, but all orders for Wiley books received in time for transmission to New York before August 20th, will be taken at the old prices.

Great interest is being shown in Japan in the development of the hydro-electric industry, according to M. Nakamura, of Tokio, an electrical engineer who is travelling through Canada in the interests of his profession. At present, the development of 1,000,000 h.p. is contemplated or under way. The production of electrical equipment is sufficient to care for domestic requirements. Electric heating, which is the department in which Mr. Nakamura is most interested, is proving productive of an unusually heavy demand for equipment, and heating appliances will have to be imported in large quantities, he says.

WATER POWERS OF BRITISH COLUMBIA

ARTHUR V. WHITE, consulting engineer to the Commission of Conservation, recently completed a report on the water powers of British Columbia. This report, which will soon be issued by the Commission of Conservation, estimates the total 24-hour horse-power of the water-powers of that province at about 3,000,000 h.p., in round figures.

Mr. White's report completes the series of water-power reports which the commission in 1910 undertook to publish. The British Columbia investigation was commenced in 1911.

Referring to the difficulties experienced in obtaining the data in the report, and to the conditions affecting water-powers in the province, Mr. White says:—

"The season available for such reconnaissance water-power investigations as were made in British Columbia is comparatively short. One of the chief difficulties encountered is that it is almost impossible for observers to avoid over-recording in their notes the power possibilities of stream observed during high-water. Young engineers are impressed by the quantity of water coming down the rivers, and have not the advantage of having observed the same streams at their low-water stages, nor have they always the knowledge of measurements of the flow of similar streams to temper their judgment.

Power Conditions are Unique

"The conditions affecting powers in the province are unique, and do not closely correspond to those existent in other portions of Canada. This is especially true of the mainland Pacific coast. One cannot but be impressed with the fact that coastal water-powers in British Columbia, which to the casual observer appear to be of comparatively small amount, nevertheless may, when economically and fully developed, yield several-fold the estimate of power, if appraised upon the same basis as similar streams in Eastern Canada. Glaciers, snowfields, and heavy rainfall abound, and, with many storage possibilities, constitute unique factors which contribute to enhance the values of powers. These conditions, on the other hand, emphasize the necessity of special and very careful engineering investigation and expert handling."

Power site tables giving summarized data with regard to the various water-powers, are given in the report, which says, in reference to these tables:—

"Owing to the topography of British Columbia and the relative small extent of territory covered by detailed topographic and hydrometric surveys, it is practically impossible to make anything like a close estimate of many of the water-power possibilities. Both the confines of the watersheds of many of the available streams and their run-off are unknown. In such cases any figure purporting to give the available amount of power is at best only an estimate indicating possibilities.

Three Million Horse-Power

"The power tables contain summarized statistical data regarding the water-powers. It is not practicable to indicate any details of information upon which the tabular estimates are based, but all available data have been used. Effort has been made to keep on the conservative side, and totals for the province, based on the tabulated estimates, can only fairly be compared with estimates for other large territories by taking into account the conservative character of the deductions. . . . Estimated quantities are on the basis of 24-hour horse-power, 80 per cent. efficiency. If comparison is made with other estimates of horse-power giving theoretical quantities, then our estimates should be increased 25 per cent."

Following is the estimate of the powers in the province, which has been divided into districts for the purposes of the report:—

	24-Hr. Power.
1. Columbia River and tributaries (north of the international boundary): This comprises the portion of the province lying between its eastern boundary and the watershed of the Fraser River	610,000 h.p.

2.	Fraser River and tributaries: This includes practically the entire area of the great interior plateau	740,000 h.p.
3.	Vancouver Island	270,000 h.p.
4.	Mainland Pacific coast and adjacent islands (except Vancouver Island): This includes all the rivers north of the Fraser, which drain into the Pacific	630,000 h.p.
5.	Mackenzie River tributaries (a rough estimate made for inclusion in this summary)	250,000 h.p.
	Grand total,	2,500,000 h.p.

The above total includes about 250,000 h.p. for plants already in operation, but it does not include about 400,000 h.p. for power possibilities on streams like the Fraser, Thompson, Skeena and Naas Rivers on which, because of the proximity of railways or possible interference with the salmon industry, economical development cannot be considered under present conditions. Also there is still considerable territory, especially in the northerly portion of the province, which it has not been possible to investigate fully. These areas may yet disclose a considerable amount of power, says Mr. White.

HOW TO REDUCE RISKS IN EARTHWORK*

By Halbert P. Gillette

FEW classes of construction are so difficult to control economically as earth excavation. Rainy or freezing weather may completely upset the best-laid plans and cause a severe financial loss. Usually most of the working gangs are common laborers, quite irresponsible, quitting at the slightest provocation, often with no provocation.

The character of the earth itself may vary greatly from week to week, or even from hour to hour. The length of haul is seldom constant, even for one day. Small wonder, then, that no ordinary class of contracting is more hazardous than earthwork.

Experience Necessary in Estimating

The first great risk is taken when the estimate is made as to the classification of the excavation. Here it is that experience counts so much in favor of an older man, and lack of experience hits a younger man so hard. But a young contractor is not necessarily without means of self-protection. He can employ an experienced superintendent, he can dig test-pits and make earth soundings.

When I first went into the contracting business I soon learned never to bid on excavation until I had "prospected" the job pretty thoroughly. It is surprising how much can be accomplished in a short time in this manner.

Sounding with rods is an expeditious way of ascertaining the depth to ledge rock or to hardpan, and it will also disclose the existence of boulders. But in an unfamiliar country it often is necessary to dig test-pits or small wells, so that the toughness of the earth can be judged by observing the resistance to a pick.

Often there is insufficient time to prospect the ground thoroughly. Then, if the work is in a section where your experience has been limited, don't bid at all if the earthwork is extensive.

Prospecting for Facts

Some years ago, a firm of young contractors in New York City asked me to assist them in estimating the cost of a large job of excavation in New York State. The cuts and fills were heavy, and the engineers had made no soundings. The engineers had estimated that the excavation would be 75% solid rock and 25% earth. After walking over the line, I asked one of the contractors what he thought of the "three to one" classification the engineers had made. He replied that it seemed to be "any man's guess," but that he presumed the engineers were approximately right, as they had been engaged for months on the surveys and in planning the construction. Had he known more about common engineering practice, he would have had little faith in that guess as to classification. I explained to him that about the last thing that the average engineer does on such a survey is to estimate the classification, and that then he usually guesses, often wildly. "Well," said the contractor, "we want to bid on the job, and it's too late now for us to do more than guess also." He was surprised when I assured him that in the two days remaining before the bids would be opened, we should be able to estimate pretty accurately what percentage of the excavation was solid rock. Since many of the cuts were 50 to 60 ft. deep, and quite long, it looked like an impossible job to do much sounding in two days; as for adequate test-pit sinking, that was impossible.

Boulders, Not Solid Rock

Jutting from the surface of the earth at frequent intervals was rock (gneiss) that appeared to be ledge rock, and it was this appearance that had led the engineers to estimate 75% solid rock. I pointed out to the contractor that ledge rock in southern New York State is usually grooved in a north and south direction as a result of the grinding action of ancient glaciers; but that none of the outcropping rocks that we had seen on that job were grooved or scratched in that regular manner. Hence they probably were boulders. There were other geological facts that led me to the same conclusion, but it remained to prove the inference beyond doubt.

I had noticed along the line several wells that supplied water to farmers, and these, I believed, would be rather deep-dug wells—real test-pits for our purpose. We were able to find the men who had dug some of these wells, and to learn from them that they had dug 50 to 80 ft. without striking solid rock, and that they had encountered few boulders.

In order to confirm this testimony, we put several small gangs of laborers at work sounding with rods. The results of that sounding showed that there was no ledge rock at all in any of the cuts. The subsequent excavation proved this conclusion to be substantially correct.

Naturally, these contractors bid a fairly stiff price on earth and very low on rock, and were the lowest bidders.

Adequate Plant Reduces Weather Risk

In estimating both the classification of excavation and the toughness of the materials, any nearby cuts should be examined; and local men who have done any excavation should be interviewed.

Having secured the job, it is important to reduce the bad weather risk by starting excavation as quickly as possible, and by using enough plant to rush it through before the autumn rains start. Here it is that the inexperienced contractor is apt to err. He may not order all his plant until he signs the contract; then he usually orders neither enough plant nor spare parts. Delays occur in getting the plant on the job, and several weeks of good weather may be lost before the work is going "full swing." Even then the "swing" is not "full" enough because of pennywise attempts to save money on plant investment.

I recall that a certain contractor on the deepening of the old Erie Canal in 1896 made a profit where his neighbor contractors lost money, simply because he brought, begged and borrowed a lot of equipment so that he was able to finish before the ground froze.

Have a liberal surplus of plant capacity, for surplus plant is the best investment on an earth-moving job.

Fit the Plant to the Job

The next important risk to eliminate is the risk of using a relatively uneconomic method or machine. There is no better way of reducing this risk than by having daily, weekly and monthly reports of the yardage moved by each

(Concluded on page 41)

*From "Engineering and Contracting," Chicago.

STANDARDIZATION*

By Guilliam H. Clamer

Vice-President, Ajax Metal Co., Philadelphia, Pa.

THERE was a time when the candle maker and the candlestick maker each made their wares to suit their own inclinations. As a consequence, seldom did the candle user find that the candle would fit his particular candle-stick. Time, in the days of candle illumination, was, however, not so precious as it is to-day, and a little more or less time consumed in shaving down its end, if the candle was too large, or if too small, in whittling a wedge to support its base, was of little consequence.

It nevertheless finally dawned upon these two classes of manufacturers that if they were to get together and standardize the size of the candles, and also make the sockets of their candle-sticks of such dimensions that the candle would properly fit, time would be saved, annoyance prevented and convenience promoted. This is one of the early examples of standardization and it has been referred to by Sir Joseph Whitworth, one of the early workers in the field of standardization, and the introducer of the series of screw threads known as the Whitworth standard.

Standard-Gauge Railway Construction

There was a time, not so long ago, when there was no United States standard track gauge for our railroads. Without standardization of track gauge it was impossible for the equipment of one railroad to be used on another. It has only been through standardization of track gauge that interline transportation has been made possible. We now travel in the greatest comfort from one end of the country to the other without a change of cars. A freight car may be loaded in Maine and without transfer of its cargo arrive in San Francisco or Key West. In fact, it may even be loaded on a barge at Key West and transferred to any part of the Island of Cuba over United States standard-gauge track.

At the present time very active progress is being made in railroad building in South America and Central America, and very shortly activities in the line of railroad building will be again resumed in Mexico; and it can be confidently expected that a Pan-American Railroad, extending from any part of the United States to Argentina, a distance of ten thousand miles, will become a reality. It is unfortunate, in this stupendous undertaking, that all sections of this railroad should not be of standard gauge. A large part of the trackage in the southern countries, as at present built and under contemplation, is of gauge which differs from our own.

I do not believe that there is one single effort which can be taken in bringing countries of the western hemisphere into closer relationship than the building of a standard gauge railroad over this entire distance.

Pipe, Screws, Bolts, Nuts, Etc.

There was a time, within the memory of the present generation, when there was no such thing as standard pipe sizes or threads; and, even more recently, when there were no standard machine screws. Each manufacturer had his own special threads. Selfish interests were so strong and the vision so narrow that great opposition on the part of the manufacturers prevailed against standardization of screw threads. Each manufacturer wished to compel the user of his machines to come to him for repair parts. He did not realize that his business interests were impaired if a user of his machine suffered inconvenience and perhaps financial loss by the shut-down of the machine because of the necessity of sending to the factory to get the necessary repair part.

There is at present before congress a bill which proposes to extend the life of the commission to standardize screw threads, created under the act of July 18th, 1918. Governmental action has in the past legalized other standards. The first attempt at standardization of screw threads, bolts, nuts, etc., was made in 1864 by a committee of the Franklin Institute of Philadelphia. This committee recommended the adoption of the system known as the United States Standard which was devised by William Sellers. In 1906, the Association of Licensed Automobile Manufacturers adopted standards for automobile screws and nuts, and a year later the American Society of Mechanical Engineers accepted the report of its committee on standard proportions for machine screws. The screw threads adopted by this society differ only in very minor details from the Sellers or U. S. Standard. This report specifies tolerances and includes standards for taps, special taps, special screws and screw-heads of various types. In 1912, the Society of Automobile Engineers enlarged their number of standards.

An act of congress in 1893, established a standard gauging system for sheet iron and steel. This was a purely arbitrary standard. Other arbitrary gauges are in use for wire and drills as well as for sheets. The only rational system is the decimal system in which the gauge number is expressed in thousandths of an unit.

There is a long list of further standardization work which has had its stimulating effect upon industrial progress, but these few illustrations I have given are sufficient to emphasize the importance and magnitude of this line of endeavor.

Only within the present century has standardization in manufacturing processes, methods and practice been seriously pursued and so-called scientific management inaugurated. Industrial progress owes much to the adoption of such standardization. In the automobile industry particularly we have out-classed the world because of such standardization. The adoption of standardization to shipbuilding during the war has put America, within two years time, in the first rank in this industry.

Quantity production can be realized only by reason of such standardization, and at the time of the signing of the armistice, quantity production in the manufacture of our airplanes was well under way and history will no doubt reveal the fact that this was quite instrumental in bringing our enemies to the realization that it was futile to further pursue the war.

Conservation Division, War Industries Board

During the war conservation of our resources became an absolute necessity and the work of the conservation division would have had far reaching effect had the war continued. The conservation division was organized to perform the function, which was expressed by the president in his letter to Mr. Baruch, as "the studious conservation of resources and facilities, by means of scientific, industrial and commercial economies, to meet war requirements."

The necessity for such standardization, as a war measure, was unquestioned, but just how far such standardization, in peace times, would be economically advantageous or economically detrimental, is speculative. Consumers are willing to pay for selection and for the gratification of their individualistic tastes as to style, color, form, etc. It is this fact which, in a very great measure, has resulted in the enormous number of commodities, differing in only slight degree from each other, now being offered on the market. A reference to but a few typical examples of our war-time conservation will be of interest in pointing out the wonderful possibilities in this direction.

Pneumatic tires, reduced from 232 styles to 9; solid rubber tires, 100 styles to 15; steel pens, 700 to 300; china and crockery, from 1,696 pieces to 330; 5,500 styles of rubber footwear discontinued, meaning a yearly saving as follows:—

29,012,600	cartons,
5,245,300	sq. ft. of lumber,
4,795	tons of freight,
1,526,423	cu. ft. shipping and storage space,
2,250,272	lbs. of material that will not have to be dyed,
74,750	lbs. of flour and starch,
30,380	gals. of varnish,
125,300	lbs. of tissue paper,
49,617	days of labor.

*Presidential address at the annual meeting of the American Society for Testing Materials.

Consider such a matter as the method of packing thread. If marketed with 200 yds. to a spool, instead of 100 and 150, there would be saved 5,146,815 ft. of lumber or 365 carloads. The saving in shipping space of finished product is about 600 cars, in wrapping paper 3½ tons, and in twine, 5 tons. Had the yardage been reduced to 100 yds. per spool it would have required over 600 cars to transport the lumber, so that the total saving is 1,200 cars by using the 200-yd. spool.

With these few examples, it can be readily realized what tremendous savings might be effected if a safe and sane policy of standardization was put into effect through co-operative agreements. It means lower cost of production, smaller capital investment, etc., with a greater amount of capital released for more useful purposes.

Research and Standardization

Emerson's definition of a standard is as follows: "That which is established by investigation or authority to be a reasonably attainable maximum of desirability."

Research and standardization should go hand in hand, but the body controlling the former should not also dominate the latter. Research should point out the ideal, namely, the highest standard of excellence which should be approached as nearly as possible by the approved standard. The final specification must of necessity be a compromise between consumer and producer, the consumer demanding the nearest approach to the ideal, and the producer agreeing to that which is commercially possible, cost, rapidity of production, service requirements, etc., all having due consideration.

Standards Often Must Advance

Research bodies should never be satisfied that the ideal which they have set up is final, otherwise practice becomes crystallized and invention discouraged. What if the locomotive of twenty years ago, or even ten years ago, were to have been considered a final standard? What if the standard locomotive or standard cars recently adopted by the U. S. R. A. Committee were to be considered a final standard, or if the automobile of but a few years ago were no further improved upon? Such standardization, if not constantly open for revision, would, instead of benefiting the industries and mankind in general, actually do a positive harm.

Unfortunately, many standards have been adopted without a proper knowledge or without due consideration, and when such standards are once established it is exceedingly difficult, costly and inconvenient to abandon them. The one great shining example of this was the adoption of our cumbersome and unsatisfactory system of weights and measures.

Recommended D.C. for Niagara Power

When the great Niagara Falls power plant was to have been installed, expert opinion was secured to recommend whether direct or alternating current systems should be used. This was at a time when alternating current systems were quite new. Lord Kelvin, a great authority, recommended the installation of direct current apparatus. In the light of our present day knowledge on this subject, just think what a tremendous mistake that would have been. When it was finally decided to install alternating current, Professor Roland, of Johns Hopkins University, was consulted regarding the nature of the alternating current which should be used. After a painstaking investigation he recommended that current be delivered at 25 cycles. It, therefore, so happened that the expert advice that was followed in the installation of that plant resulted in the establishment of a standard for the current supply which has stood the test of time. In such an installation there is involved not only the power plant itself but all the existing circuits and equipments connected therewith, and it may therefore be realized how costly and inconvenient it would be to change, in a case of this kind, from one standard to another.

It frequently pays to adopt new standards, notwithstanding the expense involved, rather than to continue with an old standard which is evidently wrong and inefficient. Many examples exist in machine design, and in the standards adopted by the Master Car Builders' and Master Mechanics' Association and other standardizing bodies which are universally acknowledged as poor; but as the equipment has been built up about such standards and as to change would result in an enormous cost, they are unfortunately continued.

Cost Accounting and Industrial Co-Operation

Some time ago the New York milk dealers asked for an advance in the selling price of their commodity. They were unable to show the actual cost of milk delivered to the consumer and were therefore not in position to substantiate their demands. Investigation revealed the fact that adequate and reliable cost-keeping systems are rare. Some attempts have been made in certain industries to establish standard cost-keeping systems—the American Foundrymen's Association has a committee on the subject. They have retained an expert who acts in an advisory capacity to its members.

The cast-iron stove manufacturers have done the same. It was found that two manufacturers producing an identical line of stoves, exhibited widely different costs for the different types. A certain small type was sold by one manufacturer below the cost price of another, whereas, a larger type could not be produced by this same competitor at the latter manufacturer's selling price. The explanation is simple, namely, they used different methods for distributing costs.

With a standard cost-keeping system within an industry, all would be benefited because all comparisons of the many items going to make up the cost would be upon an equal basis. A most important assistance could be rendered our industries if there should be organized a National Bureau for Establishing Cost Systems, the function of which should be to investigate the accounting systems in vogue in the industries, and to render assistance in the establishing of standard cost accounting.

During the war startling facts were revealed in this connection. The cost, as submitted by different manufacturers, on the same specification were so widely divergent that upon the "cost-plus" basis the government would have been called upon to pay widely varying prices for the same commodity. The need for standardization in this connection is so apparent that the United States Chamber of Commerce at a recent convention passed a resolution favoring a system of uniform cost accounting in each industry. This resolution had the endorsement of approximately 3,000 men representing all lines of commercial and industrial interests, and emphasizes the growing desire and tendency of industrial leaders to do away with the rule of guess and gamble and to establish their industries upon the science of correct and adequate records and account. It is only by such means that the present day gross inefficiencies will become recognized and eliminated. True advancement in industrial management and operation can best come through industrial co-operation; it would be a pity to allow the fruits of the co-operation which was established during the war to be wasted now because of the throttling power of the now generally conceded unwise legislation which was enacted some years ago, namely, the so-called Anti-Trust Laws.

Benefits Capital and Labor

The value of industrial co-operation was well recognized and greatly encouraged by the government during the war. Without such co-operation the wonderful productive capacity of our industrial establishments could not have been availed of to its fullest extent. Through standardized conditions, standardized records and standardized accounting, industries can be brought under intelligent government supervision and control. It would thus only be possible for such co-operation to proceed and be encouraged without doing final harm to the public. In fact it would lead to the decided benefit of labor and of the public as well as to capital.

To emphasize the attitude of the present day in this connection, I will quote a resolution of the United States Chamber of Commerce, recently issued by that body, which so strongly represents our American industries:—

"*Resolved:* The war has demonstrated that through industrial co-operation great economy may be achieved, waste eliminated and efficiency increased. The nation should not forget, but rather should capitalize these lessons by adapting effective war practices to present conditions through permitting reasonable co-operation between units of industries under appropriate federal supervision. The conditions incident to the period of readjustment render imperative that all obstacles to reasonable co-operation be immediately removed through appropriate legislation."

International Standardization

Standardization is the keynote to convenience, comfort and efficiency. We are so accustomed to the use of our fundamental standards, weights and measures, expression in language, national currency, postage, etc., that we do not fully realize what the establishment of such standards means to us individually, and to our national prosperity. Were each state to have a different language, a different standard of weights and measures, etc., we would not now be united into a vast and prosperous country. There is nothing that will promote international trade co-operation and good fellowship so much as would the establishment of wise and mutually satisfactory standards, some of which may be classified as follows:—

1. *International Language.*—National jealousies would no doubt prevent the adoption of any of the existing languages, unless the power of the nations now using such language should become sufficiently strong to enforce it. Germany, in her deep-seated plans to rule the world, had done all in her power to establish the German language in schools and colleges of many lands. Had her plans succeeded, the German language would no doubt have been enforced upon the world as it was in Alsace-Lorraine after the war of 1870.

The English language has long been the prevailing language in the world of commerce, and with the now still greater alliance of the Anglo-Saxon races will no doubt be extended. The English language as a standard leaves much to be desired when compared with the ideal; simplified spelling would help materially. The commercial advantages which would accrue temporarily (one generation at least) to the English speaking people of the earth, were the English language to become standardized, would be so great that such adoption would be sure to be frowned upon by all other nationalities. This being a fact, two entirely neutral languages have been proposed; these proposed languages being purely artificial, one knows as Volapük, meaning "world speech," published in 1879, and the other Esperanti, named for its originator, proposed some years later.

Artificial World-Language Needed

The International Congress of Philosophy, which met in Paris in 1900, defined the following essentials with which such an artificial language must comply, namely:—

The language shall serve the needs of daily life and business as well as the requirements of science and learning.

The language shall be so simple that a person possessing an average common school education can acquire it readily.

No doubt efforts will now be renewed toward the establishment of a standard system of expression for world-wide use.

2. *International Religion.*—Two hundred and sixty-eight religious sects, past and present, are recorded. About one-third of the population of the globe are followers of Buddha. Many Christian denominations differ from one another mainly on interpretation of the Bible.

During the World's Columbian Exposition in Chicago in 1893, a Congress of Religions was held. It was attended by representatives of the Buddhists, Mohammedans and other Asiatic religions, as well as by all Christian denominations. No effort was made at that time toward the establishment of a universal religion, but the possibility of establishing such a religion has been much commented upon since that time, and especially since the beginning of the great world conflict, which was participated in mainly by the followers of the Christian religion, each of the contestants praying to the same God for victory.

The Utopian of yesterday is the commonplace of to-day, the dream of to-day is the reality of to-morrow. We are prone to forget that our own short life-time is but as a small fraction of a second in eternity and we strive, in our imagination at least, to crowd into that small period of one generation the reforms for which the world will be ready only many generations hence.

These two subjects for standardization, that I have just discussed, would hardly seem befitting in our present highly practical age, and especially before a society which deals only with the strictly concrete subject of engineering materials. The standardization of language and religion is looked upon to-day as absolutely idealistic, but I feel very safe in predicting that in some future generation they will surely be a reality. I will now proceed with the more concrete subjects for standardization.

3. *International System of Weights and Measures.*—All are agreed that the metric system is ideal. It is in use by every civilized nation with the exception of the United States and Great Britain and some of her colonial possessions. An association, having as its object the world-wide adoption of the metric system, is in existence. This association, known as the Metric Association, is at the present time taking advantage of the world-wide desire for closer co-operation by carrying on a strong campaign for the adoption of the metric system in England and in the United States.

"Metric System" British Invention

The old German Osterling-Hanseatic League, which for hundreds of years controlled the trade of England, introduced the British pounds, both sterling and avoirdupois. We fell heir to these standards, which had been forced upon the British, through the British possession of a large part of the United States prior to the revolutionary war.

It was James Watt, the eminent scientist of Great Britain, who invented a few years after the American revolution, the decimal system of weights and measures now embodied in the metric system. Unfortunately, we did not adopt the Watt system in the early days of our independent existence, neither did England adopt it notwithstanding the fact that it was a British invention. Germany, however, soon after the war of 1870 did adopt it. Germany, during its war with France, having acquired a closer familiarity with the decimal system, was brought to a realization of its superiority over their own system. The metric system is referred to as the French system because of the French unit (the meter) employed.

To change from one system of weights and measures to another is no easy matter and it is exceedingly costly. The advantages, however, to be gained are so far reaching that the loss occasioned would be soon wiped out. We are to-day suffering because of the unfortunate choice and adoption years ago of a cumbersome system. To rid ourselves of this is analogous to taking a large dose of quinine, bitter and disagreeable, but nevertheless effective, with the patient better off for having taken it.

4. *International Standard of Temperature.*—How absurd is our Fahrenheit scale, and how confusing to have one scale for scientific expression and another for commercial usage.

Other Suggested International Standards

5. *International Coinage System.*—Why not a system of coinage, as well as a system of weights and measures, based on the principle of the divisibility by ten?

6. *International Gauging System.*—How perfectly absurd are the various systems based upon numerals having no particular significance. The only scientific manner in which to express gauge thicknesses for sheet, wire, cable, etc., is in the decimal system, using preferably the metric unit.

7. *Miscellaneous Standards.*—In addition to the above standards, other standards such as screw threads, electrical rating, power rating, etc., can be internationally adopted. Already some progress in these directions has been made by the co-operation of the British Standards Committee and the American Society of Mechanical Engineers, American Institute of Electrical Engineers, and through other co-operative work.

8. *International Standards of Material.*—So long ago as 1898, there was organized in Philadelphia the American section of the International Association for Testing Materials, which section was later incorporated as our present

society, which then became affiliated with the International Association for Testing Materials. Unfortunately, the International Association was opposed to the formation of international specifications for materials, and did not encourage the organization of strong national groups. It is questionable, if it is practicable or desirable, to revive the old International Association.

In this connection, at its quarterly meeting in April, your executive committee passed the following resolution:—

"*Resolved:* That the American Society for Testing Materials looks with favor upon the proposition of inquiring diligently whether an International Society for Engineering Materials can be formed to take up and broaden the work formerly done by the International Association for Testing Materials.

"Dr. H. M. Howe, past-president of this society, is going to Great Britain and France on a number of missions of a similar general nature, and we should be glad if the appropriate engineering bodies in those and other European countries would discuss with him, as our representative, the propriety of such a step and the means by which it might be brought about.

"We believe that provision should be made for admitting the neutral countries into this organization.

"We believe that the work of such an organization should be broader than was that of the International Association for Testing Materials, and that it should cover the development of knowledge of engineering materials and stimulate the science of testing materials, leading to the erection of international specifications as standards of reasonableness."

9. *International Standards of Testing.*—This is a matter which is of very great importance, and would logically come within the scope of the new international society, if this becomes a reality.

It is to be hoped that through the world war the old "sores" established upon the principle of careful selfishness will have been largely eliminated, and through a League of Nations there shall be established a permanent basis upon which humanity may progress upon modern lines, leaving behind it the old prejudices and really establish a brotherhood of man, which may rest upon a permanent foundation having a realization that the human race is after all but one large family, and that national border lines are but of artificial creation.

Standardization Bodies

The work of standardization in this country has been more or less fragmentary. Such work has been undertaken by individual manufacturers, also by individual consumers, and by associations representing only producers and associations representing only consumers.

A great deal of creditable work has been done by the National Bureau of Standards and some work has been undertaken by the American Institute of Mechanical Engineers, although the constitution of the latter society forbids the adoption of standards. This society, however, accepts its standard committee reports and sets its seal of approval upon the committee's recommendations.

A vast amount of work has been done by the Society of Automotive Engineers in the standardization of automobile parts and recently in aircraft parts. The Master Car Builders' Association and the Master Mechanics' Association have directed their efforts largely to standardization of railroad rolling equipment. The American Railway Engineering Association has devoted its attention primarily to railway subjects. The American Institute of Electrical Engineers and the Electric Power Club have undertaken much standardization work in connection with electrical equipment. Other standardization bodies are at work in various fields.

With the object in view of co-ordinating the standardization work of these various bodies, to foster co-operation between all interested organizations and government departments and to avoid duplication of effort, during the last year the American Engineering Standards Committee was organized. This committee was formed by joint action of five national engineering societies. Our society, being one of that number, therefore became one of the founder societies which organized this committee.

The work of this committee had only about begun when action was taken toward greatly enlarging the size and scope of the committee as originally planned, and proposals were set forth and preliminary action taken to reorganize the committee into an American Engineering Standards Association embracing the subject of safety codes, fire protection, etc.

A considerable amount of discussion has been taking place, questioning if there is any added advantage in having the seal of approval of this committee placed upon the specifications presented to it. It is this function only which the American Engineering Standards Committee contemplated exercising, and this policy will no doubt also prevail if the committee is enlarged and organized as the American Engineering Standards Association. It is quite a serious question as to which is the better method: To grow slowly and conservatively, beginning with an amount of work which can be expected to he handled properly in a reasonable length of time; or to immediately attempt to handle the vast amount which has been more lately contemplated and in so doing incur the danger of at once becoming cumbersome and top-heavy. This is a problem which will remain for the interested societies to pass their judgment upon. Personally and unofficially, I feel that there is a real need and a real field for such a committee or association, and it but remains for the various details as to organization, policy and methods to be worked out and these should have most careful consideration.

Standards Association and Specifications

I feel that the seal of approval of such a committee or association would give great weight and added recognition to a specification. I believe, however, that it would be a decided mistake for such a body to attempt to pass upon the substance of a specification, or to choose between two conflicting specifications covering the same subject which may be presented by two distinct standardizing bodies. No such specification should have the seal of approval unless the specification representing the joint action of such bodies be presented. All such standards, when finally adopted as American standards, should be ever open for revision, otherwise practice will become crystallized.

National engineering bodies are in operation in England, Canada, France and Holland, and it can be confidently predicted that such bodies will be organized in other countries in the near future. Because of our present excellent and rapid means of communication, all the countries of the world are being brought in much closer relationship than ever before and in the immediate future there will begin an era of intermingling of the peoples of the various nations of the earth to a far greater extent than ever before and it is therefore reasonable to assume that before many years have elapsed the needs of the world will demand international standardization to an ever-increasing extent.

The Union of Canadian Municipalities is holding its annual convention this week at Kingston, Ont. Mayor Bouchard, of St. Hyacinthe, Que., is president. H. G. Acres, hydraulic engineer of the Hydro-Electric Power Commission of Ontario, and A. Amos, chief of the Hydraulic Service of Quebec, are on the program for addresses on the undeveloped water-powers of Ontario and Quebec.

Chairman Smithers, of the Grand Trunk Railway, is expected in Ottawa soon to discuss with the government the question of the acquisition of the Grand Trunk by the govment as part of the national railway system. The negotiations in London last summer proved abortive. While the company needs financial assistance, and is prepared to sell out, it is essentially a question of price. The government's offer, which it has not shown a disposition to raise, but which the company has declined to accept, contemplates a 999-year lease, the assumption of liabilities and the guarantee of a rate of interest on the preferred stock equivalent to an average dividend during a term of years when the stock earned dividends. Something would probably be paid also on the common stock.—From "The Toronto Telegram."

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PRINCIPAL CONTENTS

MATHEMATICIANS ENTER INDUSTRIAL FIELD

PROBABLY for the first time in the history of science, professional mathematicians have formally entered the industrial field. Three New York mathematicians have established a consulting office with the object of handling special problems arising in industrial work for the solution of which the knowledge of mathematical specialists can be utilized to advantage.

Each of the members of the firm has been privately engaged for some time in work of this nature in addition to his other professional activities, and they state that "it was at the suggestion of clients that the decision was made to set up a consulting service which would extend to the industrial world the resources of modern, pure and applied mathematics."

"Problems come up in practically all technical fields," they write, "for the satisfactory solution of which the expert application of mathematics is essential. Directors of technical enterprises do not hesitate to call in the consulting engineer, consulting chemist, patent attorney or efficiency expert, but the mathematical features of technical problems are often left without adequate treatment. We are sure that this is due neither to a reluctance of industrial managers to consult mathematicians nor to a lack of desire on the part of mathematicians to handle industrial problems, but rather to the fact that men fitted for consulting service in this field have heretofore been too far removed from the industrial world. It is with the expectation of being of important service to the technical public, that we announce the establishment of our office."

The new firm will be known as Dantzig, Pfeiffer & Ritt, with offices at 500 West 116th Street, New York City. Dr. T. Dantzig is a graduate of the University of Paris. He has taught at Indiana and Columbia Universities, and during the war was in charge of the mathematical work of the instrument section of the U. S. Ordnance Department. Dr. G. A. Pfeiffer is a graduate of the Stevens Institute of Technology. He has taught mathematics at Harvard, Princeton and Columbia Universities, and is associate editor of the Annals of Mathematics. Dr. J. F. Ritt is a graduate of Columbia University. For three years he was in the Naval Observatory and has since taught mathematics at Columbia. During the war he was one of the chief ballisticians in the U. S. Ordnance Department.

Among the industrial applications of pure mathematics in which the firm claim that their services will be useful, are the following:—

Problems in statistics and probability; design of measuring and computing apparatus; design of optical instruments; mathematical treatment of problems in mechanism; mathematical formulation for patent claims of principles underlying inventions; scientific development of inventions; problems in aeronautics; and preparation of graphs, diagrams and charts.

WINNIPEG RIVER POWER CO., LTD.

ACTIVE work has begun on the construction of the new hydro-electric plant for the Winnipeg River Power Co., Ltd., on the Winnipeg River, 14 miles north of Lac du Bonnett, Man. The design contemplates the ultimate installation of six units of 28,000 h.p. each. The initial installation will be two units. The plant is being built by the Northern Construction Co., Ltd., for the power company, which is a subsidiary of the Winnipeg Electric Railway Co.

Before the war it became evident that the railway company would soon require a large quantity of power, but after plans had been prepared and a standard-gauge railway built from Lac du Bonnett, on the Canadian Pacific Railway, to the power site, it was found that the finances of the company did not permit a continuance of the enterprise.

After the armistice the project was revived, but the war had played havoc with the finances of the railway company and it was unable to assist further in the financing. The late A. C. Mackenzie, who was then president of the Northern Construction Co., entered into an agreement with the power company that his concern would build the dam and finance the cost of the undertaking until such time as the power company's bonds could be sold. No money will be due the construction company until the fall of 1920, by which time it is expected that the bonds will be marketed.

The main dam will be over 2,000 ft. long and 70 ft. high, and will be built of reinforced concrete; the power house will be of steel and brick, 450 ft. long by 140 ft. wide and over 100 ft. high.

The power from the new plant will be transmitted to Winnipeg over a 70-mile line with steel towers. A 65 ft. by 255 ft. steel-and-brick transformer station will be built at Winnipeg. Another line will connect the new plant with the present transmission line from Pinawa to Winnipeg at a point of about five miles south of Lac du Bonnett. The new plant will thus be connected with the city by two separate lines located at a considerable distance from each other.

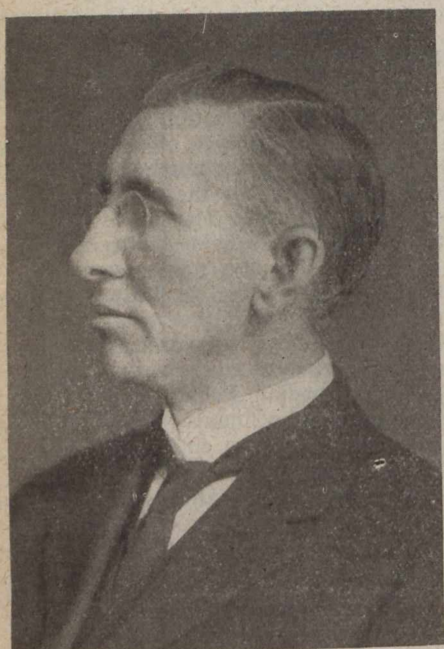
F. A. Martin, who was formerly in private practice at Niagara Falls, N.Y., is in charge of the design of the plant. He has established an office in Winnipeg. R. S. & W. S. Lea, of Montreal, are the consulting hydraulic engineers, and Louis J. Hirt, of the Pearson Engineering Corporation, New York, has also been retained in an advisory capacity.

PORT COLBORNE ELEVATOR INVESTIGATION

FOLLOWING are the members of the board that has been appointed by the Dominion government to investigate the dust explosion in the government-owned grain elevator at Port Colborne, Ont., which last week killed ten workmen and badly wrecked the $2,000,000 structure:—Lieut.-Col. C. N. Monsarrat, consulting engineer to the Department of Railways and Canals; A. St. Laurent, assistant deputy minister of the Department of Public Works; D. W. McLachlan, engineer in charge of the Port Nelson terminals of the Hudson Bay Railway; John Murphy, electrical engineer of the Department of Railways and Canals. The board is given full power to call witnesses. It is to have charge of salvaging the grain and is to make recommendations as to reconstruction.

PERSONALS

JOHN MURPHY, of Ottawa, Ont., who recently announced that he had obtained excellent moving pictures showing the formation of frazil and anchor ice, is the electrical engineer of the Department of Railways and Canals and of the Board of Railway Commissioners for Canada. Mr. Murphy was born December 17th, 1868, in Ottawa. In 1884 he graduated from the College (now University) of Ottawa, and joined the staff of the Bell Telephone Co. From 1884 he was also connected with Ahearn & Soper, who, a short time previously, had formed an electrical supply and agency house. As Mr. Ahearn was also the Ottawa manager of the Bell Telephone Co., and Mr. Soper the superintendent of the Canada Mutual Telegraph Co., Mr. Murphy came into intimate contact with the work of these two concerns. During the latter part of 1885 and the following year, Mr. Murphy was in charge of Gilmour & Co.'s arc light plant at their Gatineau mills at the falls near Chelsea, Que., incidentally acting as assistant to the general superintendent during the construction of new mills and workshops. In the spring of 1887, Ahearn & Soper formed the Chaudiere Light, Heat & Power Co., engaging Mr. Murphy to assist in the installation of the lighting system and to take subsequent charge of its operation. This company at first rented water power but soon built its own hydraulic and steam plants. Mr. Murphy was power superintendent, and practically the whole engineering staff under Mr. Ahearn, who acted as president and chief engineer. In 1894 the Chaudiere Co. and two other concerns were amalgamated as the Ottawa Electric Co., bringing five water power plants and one steam plant under its management, and Mr. Murphy was appointed Superintendent of Power Houses, retaining that title until 1906, when he was appointed to his present position with the Department of Railways and Canals and the Railway Commission. In 1891 the Ottawa Electric Railway began operation, having also been organized by Ahearn & Soper. Mr. Murphy acted as consulting engineer to this enterprise from its inception until 1906. From time to time he also acted as consulting engineer to a number of other enterprises, including, in 1902, the Montreal Locomotive Works at Longue Point, and in 1910, the Dominion Iron & Steel Co. and the Dominion Coal Co. During the last year of the war, the Fuel Controller of Canada appointed Mr. Murphy as his special agent to prevent coal consumption for the production of power at points where hydro-electric power was available. Many thousand tons of coal were saved as a result of Mr. Murphy's efforts at a time when coal was the most important of all products to a very great many Canadians. Ever since his appointment by the Federal Government, Mr. Murphy has been acting as consultant for almost every department of the government in which hydraulic or electrical problems have arisen. He is a member of the Dominion Power Board, and has been a member of the Canadian section of the International Electro-Technical Committee since its formation. He is also a fellow of the American Institute of Electrical Engineers and a councillor of the Engineering Institute of Canada. In 1915 and 1916, Mr. Murphy was chairman of the Engineering Institute's Ottawa branch. At the Institute's last annual meeting, he read a paper on railroad electrification, and also discussed, in a most interesting manner, hydro-electric ice troubles.



CAPT. J. P. CORLEY, of New York, has arrived in Canada for the purpose of taking charge of the pump department of the Canadian Ingersoll-Rand Co., Ltd. His headquarters will be at the company's Toronto office.

LT.-COL. H. R. LORDLY, formerly construction engineer, Lachine Canal, has returned to Montreal from France, and will open an office as consulting engineer. Col. Lordly took the 5th Pioneer Battalion overseas in 1916.

N. S. BRADEN, sales manager of the Canadian Westinghouse Co., Ltd., of Hamilton, has been elected vice-president of the company. H. M. BOSTWICK, assistant sales manager, has been appointed sales manager to fill the vacancy created by Mr. Braden's promotion.

GEO. K. MCDOUGALL, consulting engineer, Montreal announces that he has taken Major E. Raymond Pease, D.S.O., into partnership. The name of the new firm will be McDougall & Pease. They will specialize in industrial applications of electricity, illuminating engineering, electric power stations and high voltage power transmission.

MAJOR N. M. HALL, O.B.E., has arrived home from overseas. Major Hall graduated from McGill University in 1907, in mechanical engineering. Going to Vancouver, he became associated with the firm of Ducane, Dutcher and Co., consulting engineers. In 1915 he enlisted with the Royal Engineers as a lieutenant. He went to France in December, 1915, and won his majority on the field.

ROBT. H. PARSONS, who, previous to the war, was in charge of the water works of the city of Edmonton, is now in Canada in the interests of John Birch & Co., Ltd., London, Eng., with whom he has accepted a position as sales engineer. Mr. Parsons will make his headquarters in London. During the war he was with the Royal Engineers at first, and later, with the Ministry of Munitions.

M. U. FERGUSON, city engineer of St. Thomas, Ont., has resigned, owing to alleged interference with his department by the chairman of the Board of Works. Mr. Ferguson is planning to enter the contracting field. He has been city engineer of St. Thomas for over six years, and for several years previously was city engineer of Stratford, Ont. Before going to Stratford, he was engineer on the location and construction of a number of railway lines.

H. E. M. KENSIT, who joined the C.E.F. in September, 1915, has returned to the Dominion Water Power Branch, Ottawa. He was attached to the Canadian Engineers for two years, and after being wounded at Vimy Ridge was transferred to the Ministry of Munitions, England, for a further seventeen month. Since the armistice he has represented the Dominion Water Power Branch as a member of the water power committees now sitting in England, including that of the Conjoint Board of Scientific Societies on water powers of the Empire, and that of the Board of Trade, formed at the request of the Ministry of Reconstruction, on the water-power resources of the United Kingdom.

OBITUARY

GEO. H. BAIRD, chief draftsman of the Public Works Department, Province of Manitoba, died last month suddenly at his residence in Winnipeg.