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ANNUAL REPORTS

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MERRIMACK VALLEY HYDRAULIC ENGINEERS

PRESIDENTIAL ADDRESS BY ARTHUR T. SAFFORD,* BOSTON SOCIETY OF CIVIL ENGINEERS, MARCH 20, 1935

THE author of this paper was fortunate enough, after an apprenticeship with the Essex Company of Lawrence, Mass., and the Massachusetts State Board of Health, to be asked, in 1894, to accompany Mr. Hiram F. Mills to Lowell and begin a life's work, first as assistant and later as engineer, with the Proprietors of the Locks and Canals on Merrimack River; and, by inheritance, acquire a hydraulic library of several thousand volumes, an office and shops full of drawings, models and hydraulic instruments, which James B. Francis, Uriah Boyden, Asa Swain and Clemens Herschel had designed and used. There were also in use full-sized Francis, Boyden, Swain and other water wheels; and in place and in use early examples of the scroll, flume and open settings and many early draft tubes.

EARLY MODELS OF WATER WHEELS

Among the full-sized water wheels are Boyden's first (1844, Appleton Company) turbine; Francis' first experimental wheel (1847); and small models and parts of the first inward discharge runners designed and built by Asa Swain. The modern Francis type runner, which now is almost universally selected for heads less than 500 feet, might as truthfully be called the Swain wheel.

* Engineer, Proprietors of the Locks and Canals on Merrimack River, 66 Broadway, Lowell, Mass.

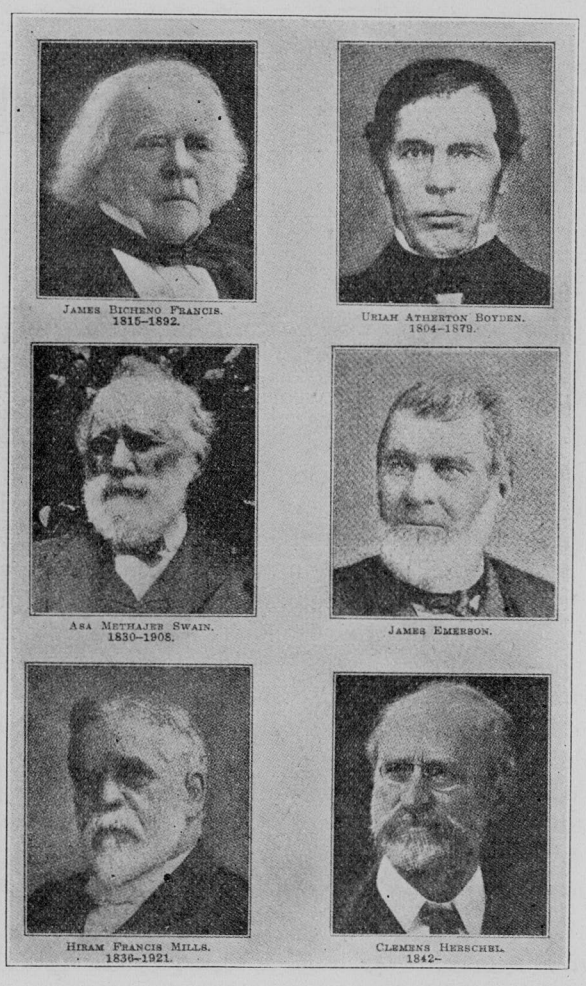

Fig. 1. — Early Hydraulic Engineers

Also, among the models found in our shop was the original diverging tube used by Mr. Francis in his experiments of 1854 and described in "Lowell Hydraulic Experiments." * This model and the results obtained from it and from the experiments on Venturi and other tubes, rounded orifices and pipes, have probably been the inspiration for many

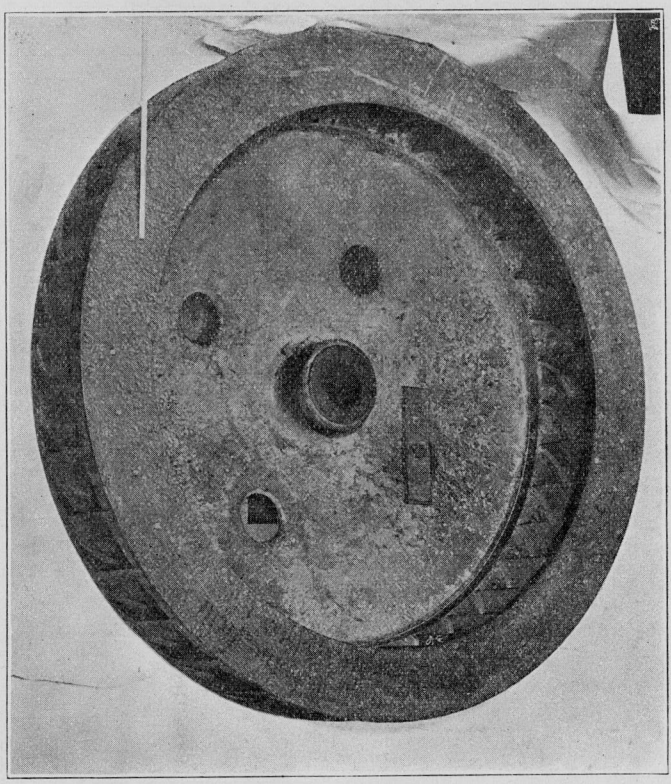

FIG. 2.—BOYDEN'S FIRST WHEEL (1844, APPLETON COMPANY)

a well-designed head gate entrance, discharge channel, quarter turn or draft tube; and, where the velocity is high, the choice of the smoothest perimeter possible with materials used. This is particularly true of the settings and materials used by Boyden, Francis and Swain, many of whose designs I have seen torn out to make way for something later, if no better.

* "Lowell Hydraulic Experiments," 4th edition. D. Van Nostrand, New York, 1883.

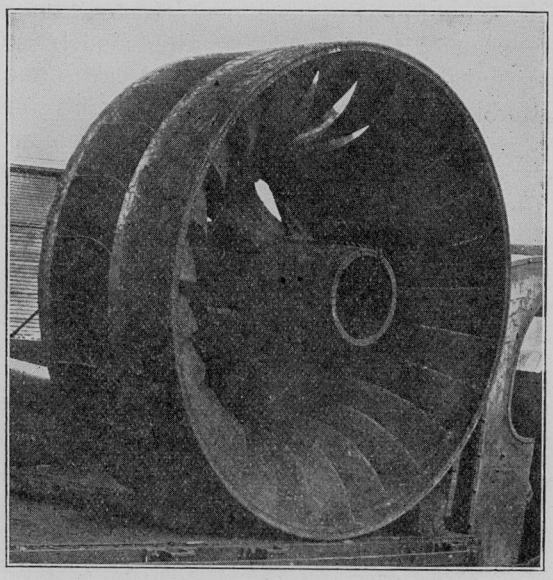

FIG. 3. — SWAIN'S 72-INCH WHEEL

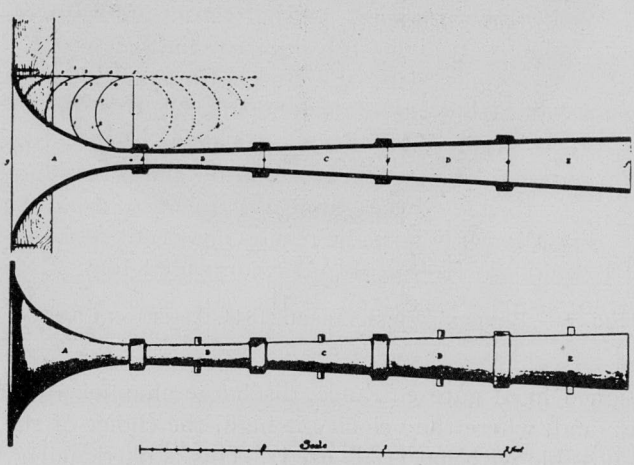

FIG. 4. — FRANCIS DIVERGING TUBE (1854)

The teaching of hydraulics and hydraulic engineering in the schools of fifty years ago was limited in scope, confined to standard works, like Unwin's "Hydraulics," and was included as a part of a course in physics. Laboratory experiments were comparatively few in number, limited, also, in scope, and, for the most part, they simply checked, in a general way, empirical coefficients, which applied more or less definitely to the few formulæ for head, velocity, pressure, friction, etc., which were even then in about the form we commonly use them. Even now, with all the refinements of modern experiments and measurements, all coefficients must be used with great care and only where the conditions of experiment are reproduced faithfully.

Early Hydraulic Engineers

The early hydraulic engineers of Massachusetts — Francis, Boyden, Swain (a millwright), Emerson, Mills, Fteley, Stearns, Freeman and FitzGerald — were engaged in designing important hydraulic works for which the information was meager. While the hydraulic principles had been well known for several centuries, the empirical coefficients were to be estimated only within wide limits. Hence the urge to re-enact older experiments on a more careful scale, to establish coefficients and formulæ and to leave to the next generation data on the absolute conditions under which they could be used. Much of the published material was in French, German or Italian, and required translation.

During my summer with the Essex Company, on rainy days I translated for Mr. Mills one of G. Hagen's treatises on friction losses in pipes. Mr. Mills did not know the German; the translator had not yet had the physics. The German separable particle, which the translation from day to day always appeared to miss, usually provoked a statement from Mr. Mills that the results could not possibly be as given him; and I could not for the moment contradict him. However, once the separable particle was found at the end of a long table of experiments, and it contradicted the previous statement, everything was well again.

Water Measurements at Lowell

The system of water measurements at Lowell, begun by James B. Francis and carried on by his son, Col. James Francis, had been established for the purpose of determining an equitable division of the permanent water from the Merrimack River, leased by the Proprietors to the mills and shops at Lowell. This required the distribution for fifteen hours each day of 3,595 second-feet of permanent water, and some

surplus during times of large flow; but the total of surplus was relatively small.

The general impression that much larger amounts of surplus could be utilized to advantage, alongside the growing use of steam power, led, in 1893, to Mr. Mills' being invited to become chief engineer of the Lowell water power company, as well as the Lawrence company; and to make recommendations to improve the property and increase its facilities to use large amounts of surplus as well as the permanent water.

Need of Improvements in Canal System

This required improvements in the canal system and the installation of more or larger water wheels in place of existing ones. Many of these required a different or greater use of the water ways to and from the wheels; more accurate measurements of the water were required from day to day to keep accurate track of the surplus. New settings in old water channels required almost every use of the principle that energy could be regained by proper design. The daily division of water among the different users and the many small uses of process water required almost every kind of measuring device and facilities for rating them.

These improvements were not easy to make because of the short time permitted for drawing off the water from the canals, which was limited to some night work and long week-ends. In most cases, the growth of the city around the canal system and the excessive cost of additional land prevented widening; and the improvements, where the velocities were highest, were limited to deepening, straightening and smoothing rather than widening.

Additional data have been accumulated and studied to know the effects of drought and flood; studies of rainfall, run-off and opportunities for additional storage reservoirs have been made with other interests on the river. These studies are now being continued, not only for the sake of the water power at Lowell, but for the Merrimack River generally.

Velocities in the canal system ranged all the way from one foot or less to perhaps eight feet a second, due in some cases to limited capacity, in other cases to obstructions which had filled in and also to the fact that after seventy-five years of use the system of five miles of canals was unbalanced. In 1893 it was too early to think of a central hydro station; consequently, the increase in equipment and use of water was made by each mill independent of the others and inside of its own yard.

Improvements in water channels have included work in the Northern Canal, which is the main feeder canal, 100 feet wide and 15 feet

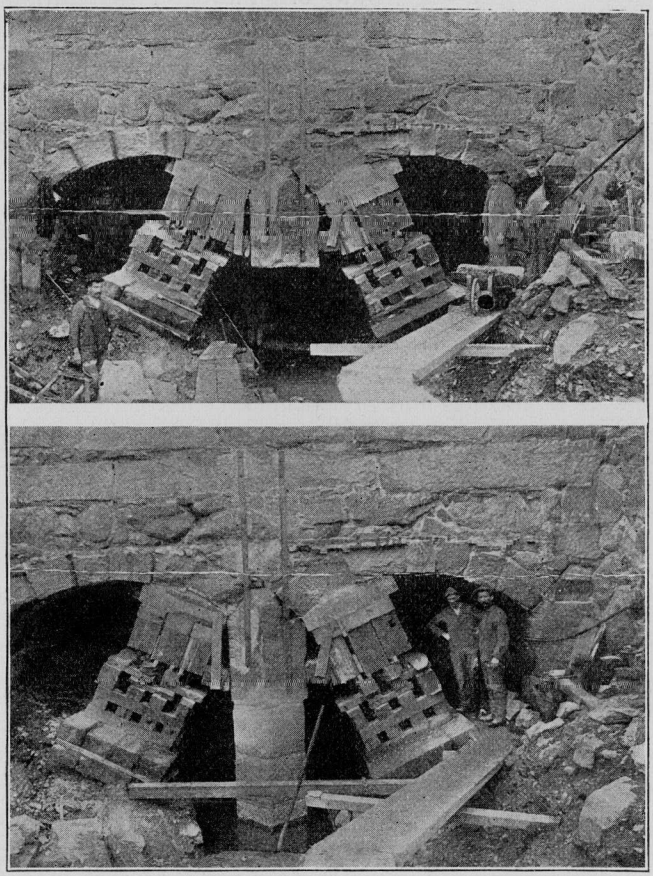

FIG. 5. — MIDDLESEX COMPANY NO. 6 MILL TAIL RACE

deep, and from this main canal down to the smallest penstock or tail-race which have required enlarging or cleaning out. Deepening has many times required shoring up old mills of many stories and undermining and building under existing walls built originally on foundation materials varying from rock to quicksand.

Favorable Years for Improvements

The years between 1894 and 1918 were favorable for increasing the capacity of the canals and installing new equipment, due to a number of factors.

The Holyoke testing flume, begun by James Emerson, had just been rebuilt under Clemens Herschel's direction, and was in a position to test full-sized units at a very moderate cost, compared with the early and expensive tests of Boyden and Swain wheels at Lowell, under Mr. Francis' or Mr. Mills' direction.

The Swain or Francis and McCormick types of runners, with many others imitating them, with settings either vertically or horizontally, singly or in pairs, were being constantly improved as tests at Holyoke showed the possibilities of higher efficiency.

The direct-driven generators required higher speed and as much power as could be delivered by a given wheel or group, as factors in their cost. The entire set-up in the different mills was being changed as rapidly as possible from mechanical drives to electric transmission of power.

The United States Geological Survey was beginning its systematic work of gaging the rivers of New England, and making available the records, which are of great value in operating a given water power.

Labor and materials were cheap, men were not averse to working long hours and Sundays; and Lowell had the laborers, masons and bricklayers of the old industrious type.

Lowell was prosperous with her industries, and southern competition was not yet a serious item.

Reference has been made to the experimental work of Mr. Francis and the men who followed him. All this was available to us and made a background for everyday use, as were also such additional experiments as were necessary to check the old and to rate such new hydraulic tools as appeared from time to time.

Methods of Measurement

For water measurements, there were in use (1) the rod floats and current meters, for determining velocity without interfering with the ordinary run of the water in the canal system; (2) weirs, including tandem weirs; (3) water wheels of fixed discharge; (4) orifices for special ratings; and (5) a big lock for bulk measurements of hydraulic meters

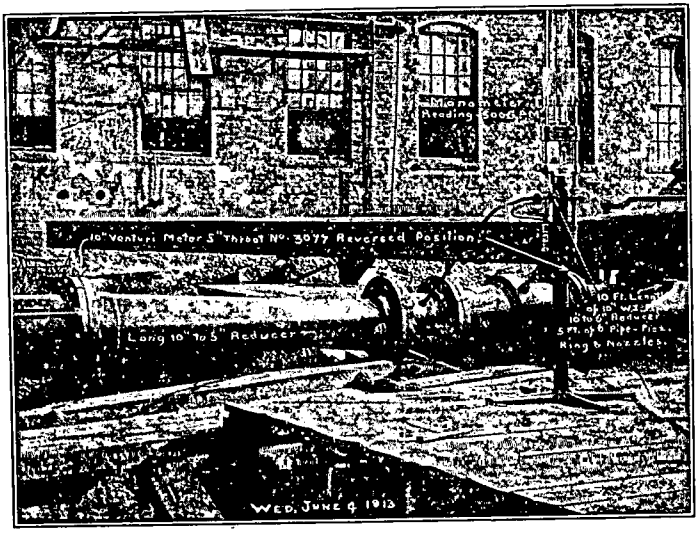

Fig. 6. — Venturi Meter — Rating at Swamp Locks

of different kinds, which discharged relatively small amounts of water. In short, there was available about everything convenient for such measurements, as well as the facilities for testing water meters of every sort under working conditions.

New measurements have included many requested ratings of current meters, Venturi meters, Pitot tubes, and some special experiments on draft tubes, pipes and channels, either in connection with the fire protection system or of structures being designed.

Fundamental Laws of Hydraulics

The fundamental rules of hydraulics for practical use with a water power company are few and easily understood. They may be complicated if coefficients are expressed mathematically instead of by natural numbers, but for our purposes the following principles, rules and formulæ have been sufficient.

On page 8 of the fourth edition of Hughes & Safford's "Hydraulics," published by the Macmillan Company, is the following statement:

> Out of all the work and thought devoted to hydraulics during the last two thousand years there have gradually been evolved the following basic theorems and formulas, which, with slight modifications based upon later experiments, are still the laws which govern the flow of water:
>
> The fundamental law of flow (Castelli, 1628):
>
> $$Q = A\,V$$
>
> Pascal's principle (1650):
>
> > Pressure is transmitted equally in all directions through a mass of fluid at rest.
>
> The velocity of falling water (Torricelli-Huygens-Bernouilli, 1732):
>
> $$V = \sqrt{2\,gh}$$
>
> Bernouilli's theorem (1738):
>
> > The law of the conservation of energy applies to the flow of water. Pressure can freely be converted into velocity and velocity into pressure.
>
> The flow of water in pipes and in open channels (de Chezy, 1775):
>
> $$V = C\sqrt{RS}$$
>
> The Francis weir formula (1852):
>
> $$Q = 3.33\,LH^{3/2}$$

To which I have added one of the Fteley-Stearns weir formulæ (p. 165):

$$Q = 3.31\,LH^{3/2} + 0.007\,L$$

H for suppressed weirs $= (h + 1.5\,h_v)$

H for contracted weirs (2 ends) $= (h + 2.05\,h_v)$

because of the importance of any material velocity of approach.

The Bazin formula (p. 169):

$$Q = mLh(2gh)^{1/2}$$

because Bazin treats a weir as an orifice.

Conditions Necessary for Application of Formulæ and Constants in Check Measurements

Perhaps the most valuable results which have come from these check measurements of ours and the futile attempts to go much beyond them have been the knowledge that, unless the conditions of experiment of these early and later hydraulic engineers have been faithfully reproduced, no dependence can be placed upon the results; and the estimates become merely good or bad guesses. A rounded corner instead of a sharp one, velocity of approach of more than a foot a second, measurements of elevation of head water or back water, any one or all of these lead to strange results and perhaps unconscious errors which may make or break the people involved in the result of such a test.

Some of the conditions found by the author will illustrate well what may result from not observing faithfully or intelligently the conditions laid down by the early experimenters.

The use of a Francis weir with a beautiful sharp metal crest, which was less than six feet above the floor of the channel of approach as used by him, had previously brought a penalty to the builders of a water works pump, when actually the contract requirements had been met, as was demonstrated several years later when the weir was raised for a further test. The velocity of approach was material and full correction had not been made.

The Fteley-Stearns weir formula increased the correction for velocity of approach about a third over the Francis figure, and if material might easily affect the answer several per cent.

With the conditions made right, six tandem small weirs of the same length and properly built, but at small expense, not only registered all the water from a given stream, furnishing process water to a number of industries, but easily detected some additional city water drawn to make up for the shortage.

A small and expensive weir of the Francis type, but located too near the discharge pipe from a series of test wells, under-registered the yield of the wells; but the measured barrel, into which the water was discharged, told the truth. The same defect had been noticed in Lowell many years previous, in the test of a water wheel, the discharge of which was forced over the measuring weir, instead of passing over it normally from practically a still condition.

A bonus was paid for some modern water wheels, on the reputation of the builders and laboratory tests of a model wheel, although some bulk tests in place confirmed the current meter measurements, which showed an efficiency about 2 per cent less than that on which the bonus was figured.

A flow curve established for a dam with rounded crest, built from a laboratory model, was found with its intended upstream face downstream; and a new rating curve made in the field was necessary.

A half turn of the wrench in the wrong direction, to throw the perforated pipe leading to a hook gage still box registering the depth on a standard weir, brought the holes against the current approaching the

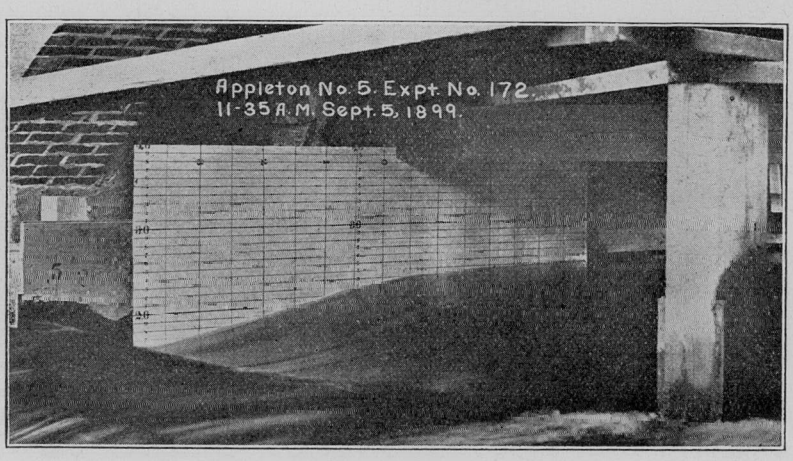

FIG. 7. — SUBMERGED WEIR HEAD AND BACKWATER

weir instead of away from it, and made a double correction necessary. This was detected by the simple plan of measuring to the actual surface of the water from a stiff plank across the flume with a home-made point gage.

Many of the hydraulic formulæ listed may be used safely beyond the limits of experiments, if the velocity of approach is negligible and the weir, gate, orifice or nozzle is properly designed and the experimental conditions of approach or get-away are duplicated; but the least departure from the test opening or appreciable velocity of approach and the corrections applied are usually mere guesswork. Gate coefficients vary all the way from about 60 to more than 100 per cent of the velocity due the head, and to use 0.60 to be on the safe side is mere cowardice.

Power Developed at Lowell

With everything here to teach good design, much was done to develop the power at Lowell up to an extent which fairly taxed the river; and about as much new equipment was installed inside the mill yards, using existing waterways, as might have been thought sufficient for a central hydro plant, if such a plant had been built during war times. The system as it stands today, with five miles of canals and 18,000 kilowatts in 60 units, has been called obsolete, but better an old-fashioned house or even a water power system without a heavy mortgage than an up-to-date one which the banks own.

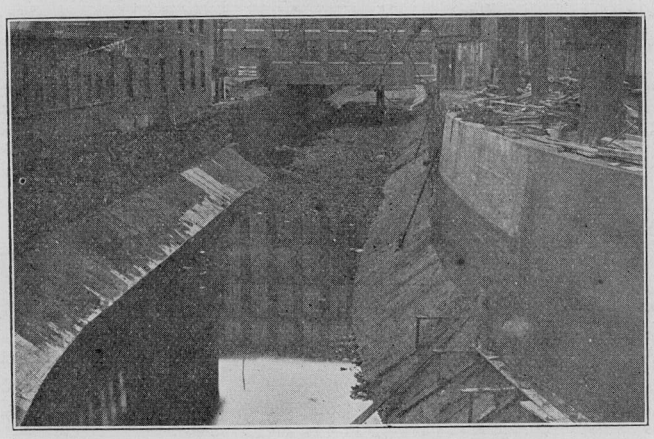

Fig. 8. — Canal Deepened and Smoothed

The design of large open channels is usually good because, when built, the additional land and excavation necessary may be increased without a proportional increase in cost, and low velocities which are usually to be sought for are easily obtained. If an old channel many years later is called upon to carry a much greater quantity of water, low velocities may be difficult, and the effort should be made to have the channels as smooth as possible, and any changes of cross section gradual, like Francis' expanding tube or the Swamp Locks flume referred to.

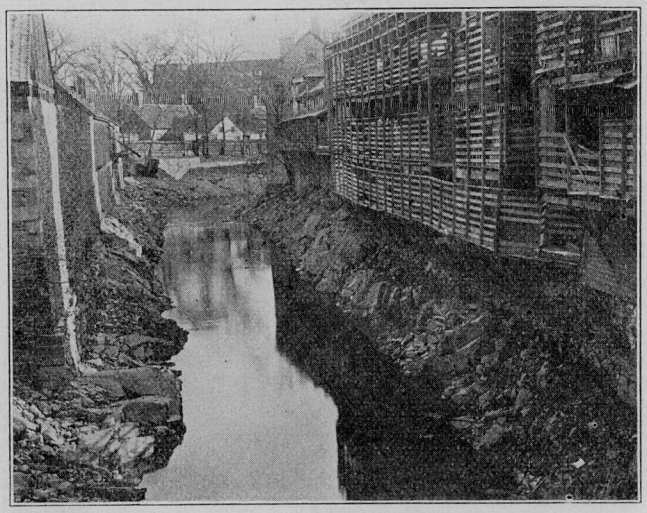

FIG. 8A. — WESTERN CANAL FROM BROADWAY — ROOKERIES

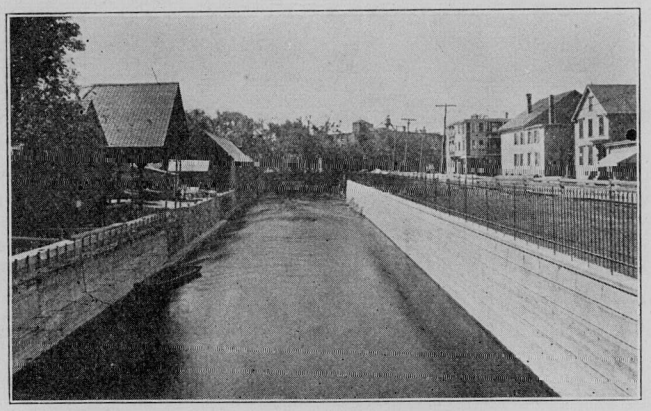

FIG. 8B. — SLUM CLEARANCE AND CANAL IMPROVEMENT

Francis' Diverging Tube

The Francis Diverging Tube, the principle that energy may be regained in part at least, and results of his experiments of 1854 are full of suggestions for the good design of water channels, and suggest rounded openings, smoothness, gradual changes in cross section; and conversely, many mistakes of design and loss of energy in head and sluice gates, canals and pipes, could have been avoided if these experiments had not been thought of simply as another Venturi tube.

On page 228 of "Lowell Hydraulic Experiments," Mr. Francis makes the following statement:

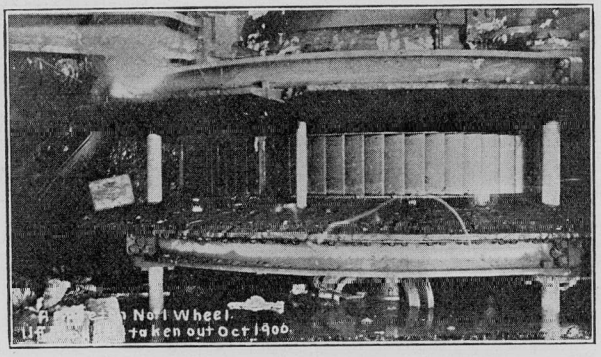

Fig. 9. — 11-Foot Boyden Wheel with Diffuser

As previously stated, Venturi, by adding a diverging tube, increased the discharge of an orifice having nearly the form of the contracted vein, and discharging freely into the air, in the ratio of 1 to 2.21. In these experiments, in an orifice without contraction discharging under water the discharge was increased by adding a diverging tube in the ratio of 1 to 2.56. Making the comparison with an orifice in a thin plate the maximum coefficient of discharge with the thin plate is 0.5928, and with the mouthpiece of cycloidal form and diverging tube the maximum coefficient is 2.4306; the discharge with the same area of orifice and the same head being increased in the ratio of 1 to 4.12.

On page 230:

As previously stated, the principles involved in the flow of water through a diverging tube find a useful application in Mr. Boyden's diffuser.

A photograph of the 11-foot Boyden wheel taken out at the Appleton Company plant is shown complete with diffuser. This wheel and

guides were of cast iron with bronze blades and in perfect condition when taken out.

On page 231:

The area of the annular space . . . where the water enters the diffuser is $0.802 \times 8.792\pi = 22.152$ square feet; and if the stream passes through this section radially, its mean velocity must be $\frac{219}{22.152} = 9.886$ feet per second, which is due to a head of 1.519 feet. The area of the annular space . . . where the water leaves the diffuser is $1.5 \times 15.333\pi = 72.255$ square feet, and the mean velocity $\frac{219}{72.255} = 3.031$ feet per second, which is due to a head of 0.143 feet. According to this, the saving of head, due to the diffuser, is $1.519 - 0.143 = 1.376$ feet, being $\frac{1.376}{33. - 1.519}$, or about 4⅜ per cent of the head available without the diffuser, which is equivalent to a gain in the coefficient of useful effect to the same extent. . . . Experiments on the same turbine, with and without a diffuser, have shown a gain, due to the latter, of about 3 per cent in the coefficient of useful effect.

If, instead of the well-proportioned tube shown, a larger pipe or tube is attached to one of given smaller diameter, the flow through the smaller pipe is increased; and whether an early Roman householder or Yankee miller is responsible, both knew what they were doing and why they made the enlargement.

Experiments at the Swamp Locks, Lowell

Some unpublished but interesting experiments made at the Swamp Locks in Lowell during 1898 were in an open flaring flume and on a somewhat large scale (the quantities measured being at times upward of 100 second-feet), involving the same hydraulic principles as Francis' Diverging Tube of 1854. These experiments had no great value except to emphasize the principles involved, but led up to extending the partitions between the different granite openings of the hydraulic gates at the Old Guard Locks near Broadway, with the idea of increasing the discharge of these gates. They also taught again the possibilities of smooth channels and freedom from obstructions.

These experiments were made in a wooden flume about four feet wide and high, which discharged into one twice as wide and one half again as high. The experiments covered a wide range from an abrupt transition from one cross section to another, all the way to sides and bottom with 10 to 1 slopes; and finally some with cleats nailed on the sides to deliberately obstruct the otherwise smooth passage of the

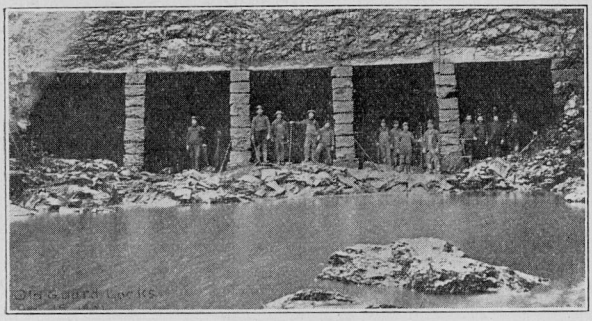

FIG. 10. — OLD GUARD LOCKS GATE CHANNELS
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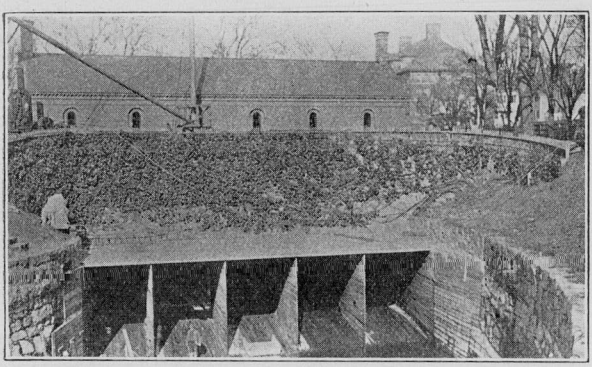


FIG. 11. — OLD GUARD LOCKS GATE WITH EXPANDING
CHANNELS

water. In a general way the head lost in getting up the initial velocity through the smallest section was regained in part up to about 75 per cent under the best conditions, but the experimental flume never approached the perfection in shape and smoothness of the Francis experimental tube. The experiments, however, because the flume and the behavior of the water could be seen, were a much better picture of the conditions and principles involved than the experiments on the diverging tube, where only the results were known.

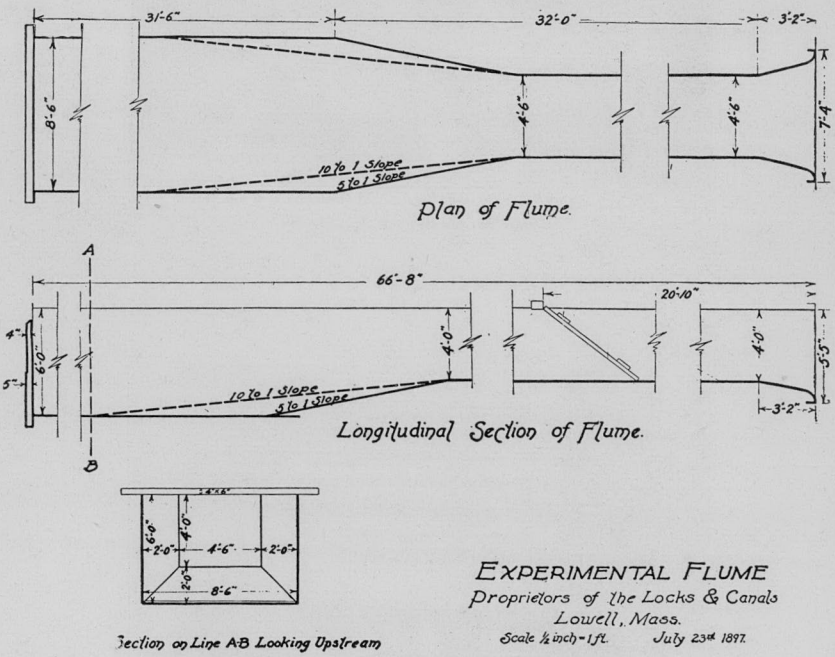


FIG. 12. — EXPERIMENTAL FLUME AT SWAMP LOCKS

The head required for entrance and velocity is well shown by the piezometer tubes on the scale board (shown in Fig. 16). The other attendant conditions are shown by several other figures.

The lessons from these experiments and the principles involved were many, and much was learned in the direction of good design of water channels. The converse of this — obstructions, abrupt changes in cross section — also was apparent to the eye.

Some of the many experiments on this Swamp Locks flume were designed to show the effect of obstructions; something which should not require any experiment or proof but is often forgotten. Unless there is

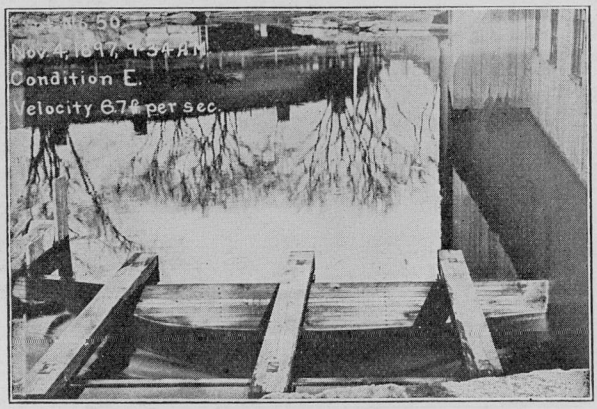


FIG. 13. — CONDITION E. FLUME AT ENTRANCE

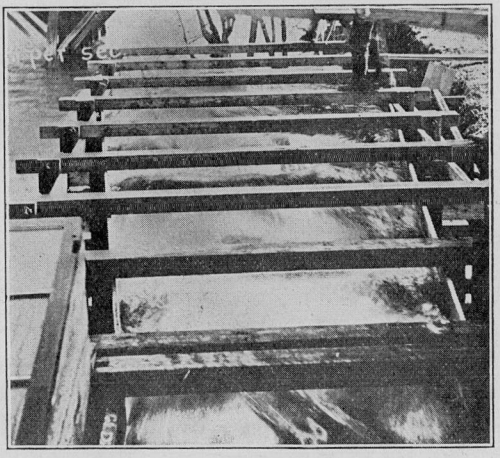


FIG. 14. — CONDITION E. FLUME SHOWING EXPANDING SIDES

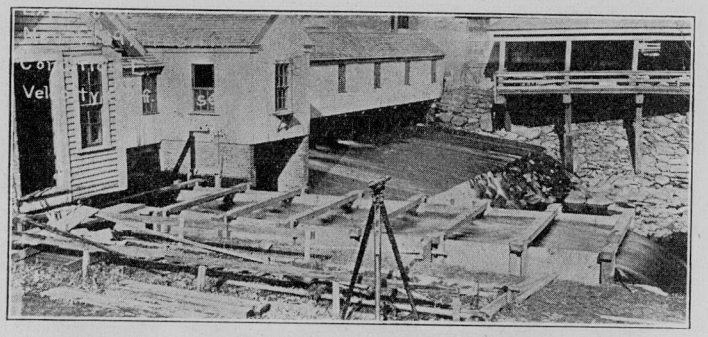


FIG. 15. — CONDITION E. FLUME SHOWING WEIR

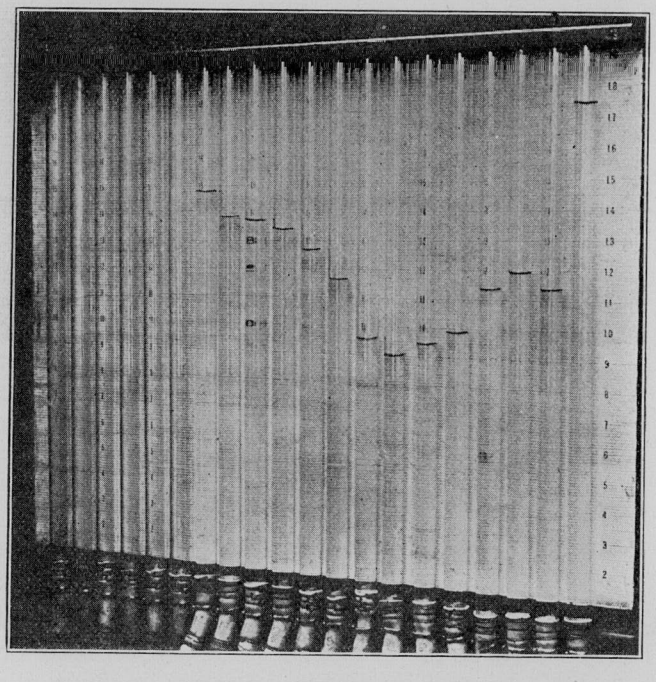


FIG. 16. — CONDITION E. PIEZOMETER TUBES AND SCALEBOARD

a deliberate requirement of obstructing the flow, as in a fishway, or a pier in canal or river, any obstructions should be avoided and if necessary the obstruction reduced to a minimum. If the velocities are low, there is no problem; if high, some attempt should be made to make

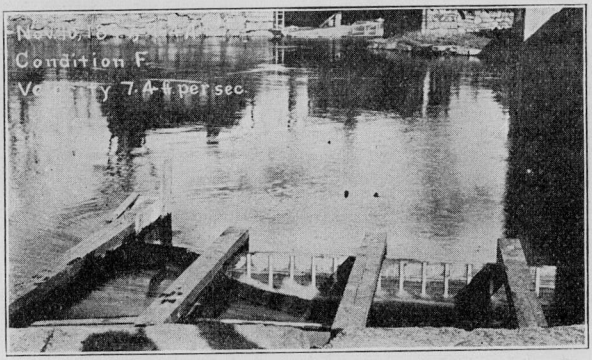


FIG. 17. — CONDITION F. FLUME WITH OBSTRUCTIONS

the up and down stream ends as rounded as possible, which usually results in a saving of perhaps 50 per cent of the additional head required to get the water by the obstruction. The same freedom from obstruc-

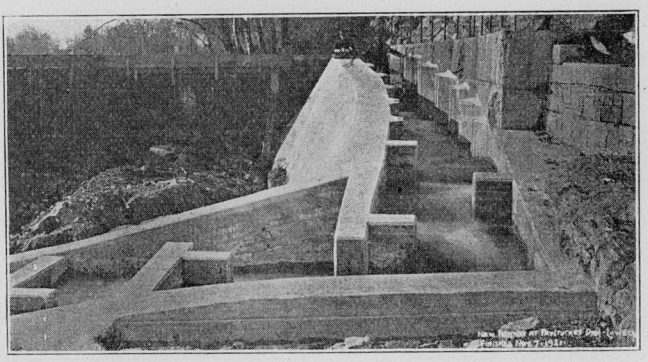


FIG. 18. — FISHWAY AT PAWTUCKET DAM

tions applies to dams, — an old one left just above a new dam; railroad piers at right angles to the railroad instead of parallel with the flow; in fact, anything to break up a uniform velocity and flow once established.

The discharge of dams, headgates, canals, penstocks, flumes, scrolls, draft tubes and tailraces can all be treated as channels over or through which water must be held or travel with the least loss of energy. Ob-

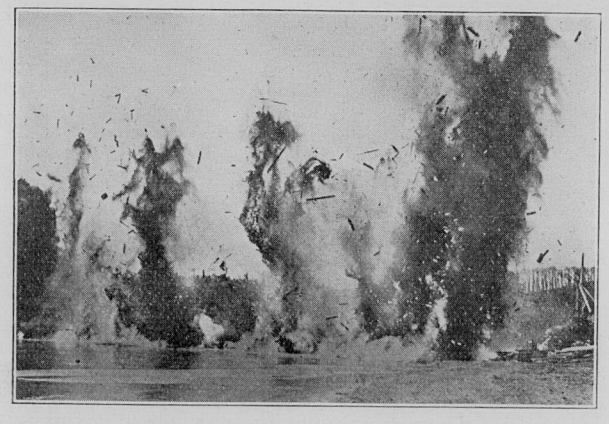


FIG. 19. — BLOWING UP OLD TURNERS FALLS DAM

structions are bad and make for loss, but dead areas and leaks are just as serious.

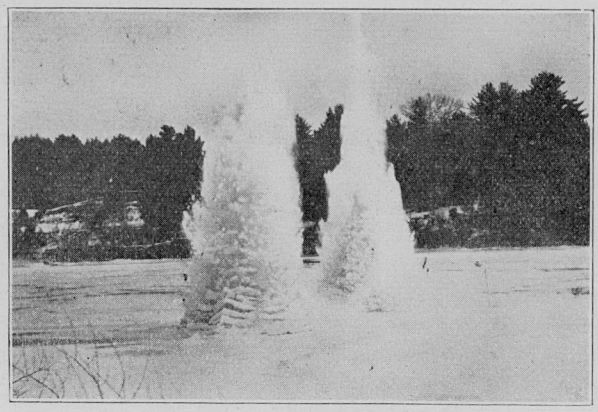


FIG. 20. — CLEARING CHANNEL, MERRIMACK RIVER

When the Chicago drainage canal was being considered, Mr. Desmond FitzGerald, as one of the advisory engineers for the canal, asked to have certain slope measurements made in our Northern Canal about

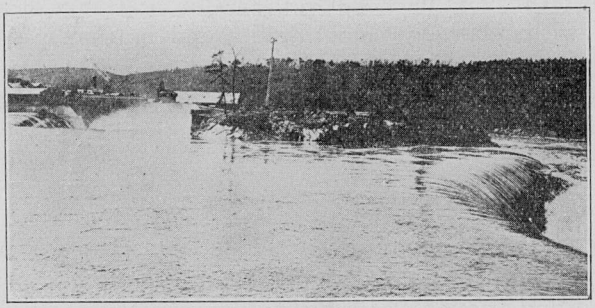


FIG. 21. — FREE DISCHARGE OVER DAM WITHOUT OBSTRUCTIONS

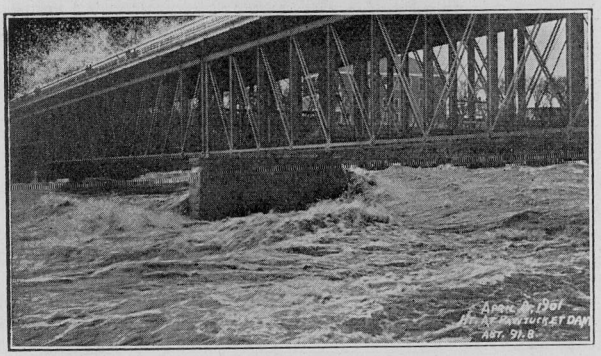


FIG. 22. — HIGHWAY BRIDGE PIER DURING FRESHET

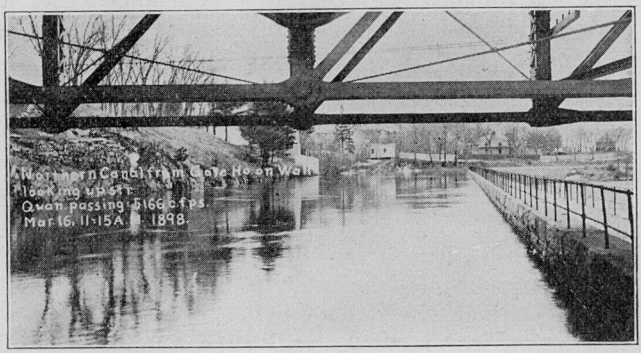


FIG. 23. — MEASURING STATION FOR CANAL SLOPES

a mile long and for the most part of a uniform section of about 1,500 square feet, with relatively smooth sides and bottom. A loss of less than six inches to the mile under conditions of moderate velocity pointed to definite good results expected in the drainage canal and later that from Turners Falls to Montague, some two miles long; but the velocities were kept down.

Channel Flows

Many good water channels are spoiled by obstructions, and not always has the need of good design been appreciated. Entrance head, velocity head and friction head all become important if high velocities are used; and all of these become negligible if velocities are low. The

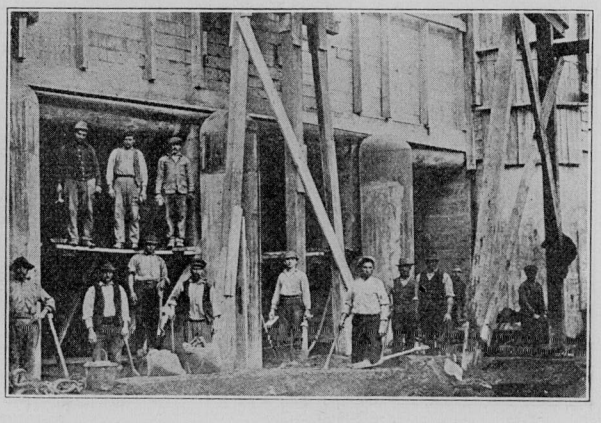


Fig. 24. — Headgate Entrances, Turners Falls

design of head and sluice gates to avoid the entrance losses, the use of smooth materials and finish to reduce friction and the limiting of obstructions either in number or character to a minimum, offer many interesting studies of design, the neglect of which may negative or destroy the efficiency of a perfectly good generating or pumping unit.

The effect of good and poor design in open water channels can be seen and losses measured readily, and the mistake, if any, in the first design corrected. With closed channels, and particularly those which once filled are rarely open for inspection without interference with the output of the station, many curious conditions obtain, some of which may be improved, some too expensive to attempt. The good design should start with the first structure, through which the water approaches the property. When the single slow speed water wheels gave way to the faster horizontal single, pairs and even four or more on a line, it was thought that

they could be placed in a flume and forgotten. The increased speed in itself required more careful design, independent channels of discharge, and with the changes in section necessary, these should be made as gradual as possible.

Water Wheel Settings

Many of the complicated designs and beautiful lines of scroll settings may not increase the output of a given hydro unit; and sometimes one wonders if the large square open area of the Holyoke testing flume was not as favorable as the most complicated scroll. Structurally the scroll is best adapted for the setting; but the velocities through it should be low.

A paper* by Edward Pierce Hamilton and myself, called "The American Mixed-Flow Turbine and Its Setting," presented in May, 1922, was devoted principally to the development of water wheels from their early beginnings; and their settings were only mentioned where important.

The development and increase in power and efficiency of water wheels went ahead much faster than the study and design of their settings; and even now there is a tendency to cramp the style and good effect warranted by a given water wheel or wheels by poor settings, obstructions to the flow of water in both the in and out channels, and perhaps other more serious faults, like being set too high or low, or installed to run at a speed only possible under the most favorable conditions of head or water. Part of this is due to the often excessive speed of the generator if a hydro electric unit, or mechanical grinders if in a pulp mill; or to reasons of false economy in the design of the building in which these units are located.

Some of the slower speed wheels have shown efficiencies by test which have not been reached by the higher speed and propeller type.

A water wheel, unlike most steam engines, must work within narrow limits of speed and capacity, and low water, back water, anchor ice and other limitations of our New England rivers should all be carefully considered in the setting; and if steam and water power are coupled together, there is no advantage in having the steam engines, under certain conditions of low or back water, dragging the wheels through the water, something which is not unknown.

Most of the rules for good design of water channels and settings are very simple and need little more than a consideration of velocity, the head required to get it up, and, if changed, either increased or reduced by gradual and well-shaped cross sections.

In 1914 the writer tested a 58-inch Smith type K vertical turbine

* Transactions, American Society of Civil Engineers, Vol. LXXXV, p. 1237 (1922).

set in a very liberal scroll, and with an easy flaring draft tube ending in a liberal elbow. The generators were of an early type with an excess of

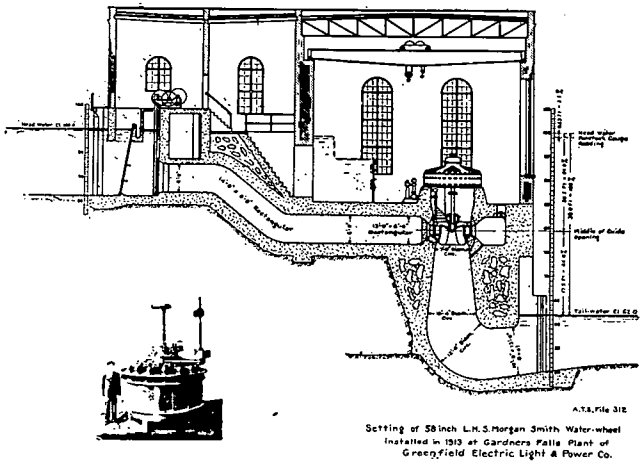


FIG. 25. — S. MORGAN SMITH 58-INCH TYPE K WHEEL

copper, and the wheel efficiency reached well above 90 per cent, a result which is high for water wheel efficiency. A recent communication indicates that these good results have been continued in practice.

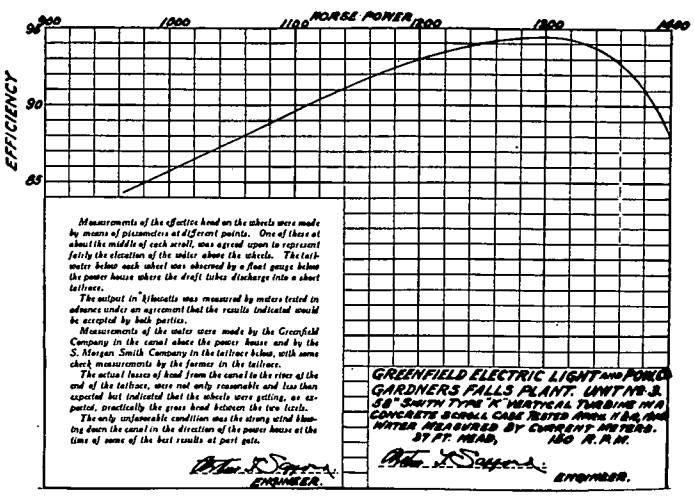


FIG. 26. — S. MORGAN SMITH EFFICIENCY CURVE

A plate from page 1271 of the paper referred to shows well by cross sections, to scale, the relative change in capacity and speed of wheels in

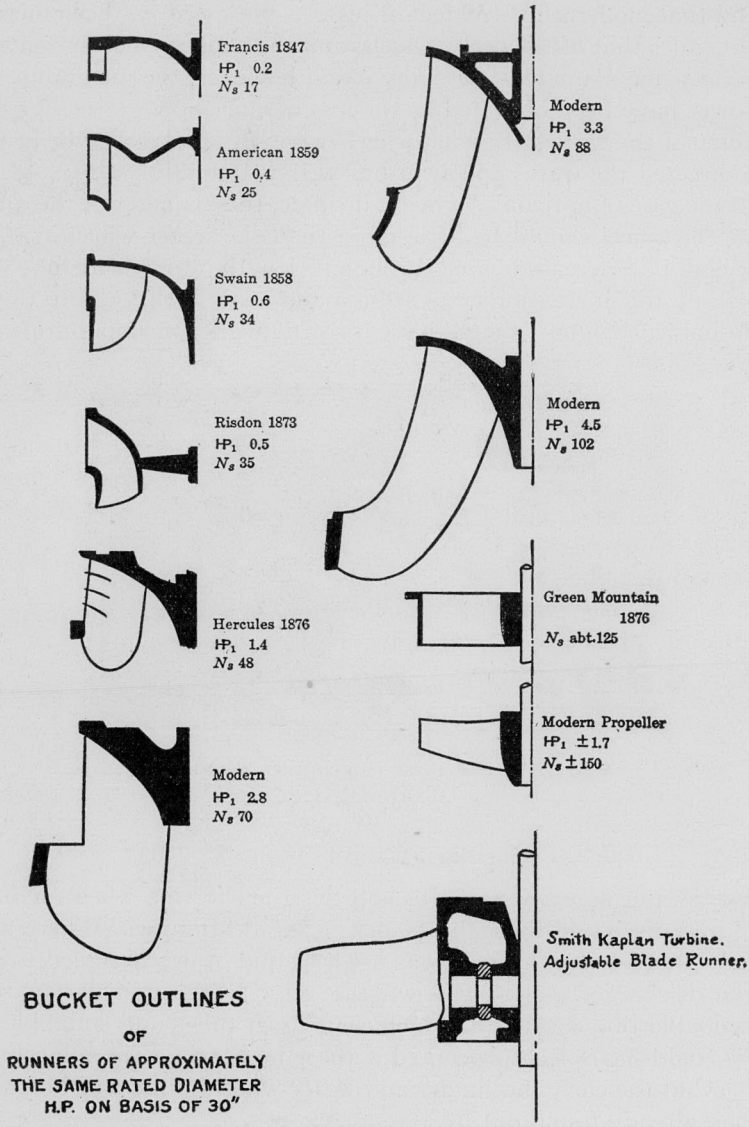


FIG. 27. — BUCKET OUTLINES, SHOWING DEVELOPMENT

about one hundred years of practice. In a general way, under a given fall, and that moderate, — 50 feet or less, — the speed has been increased to eight times that of the early wheels, and the capacity nearly ten times, all for the same diameter. In many cases, however, the maximum speed and power have been obtained at the loss of efficiency.

Some of the earliest Boyden wheels were set in a scroll tube or flume which directed the water downward as well as laterally.

In the case of horizontal wheels, if single, the diameter of the quarter turn at the wheel should be little more than the water wheel at its discharge end, but increase in area through its length into a draft tube which will pick up this increasing cross section and carry it through to the outlet; if double, each unit should have its own quarter turn and draft tube.

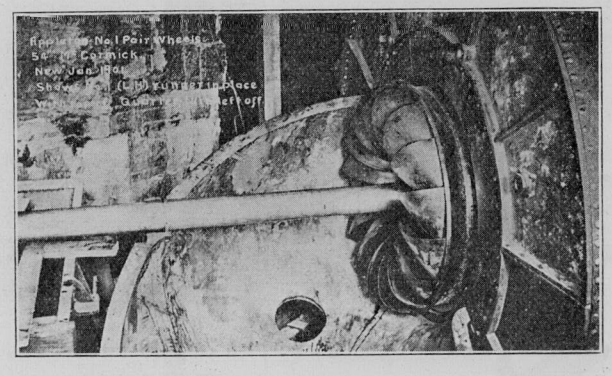


Fig. 27A. — 54-Inch Horizontal Wheel in Quarter Turn

Flaring Draft Tubes

Asa Swain, as early as 1870, had designed for his wheels a proper setting and discharge through a short flaring draft tube. Where a pair of wheels on a horizontal shaft was used, he and others designed to separate the discharges and slow down the velocity through flaring tubes. It is probable that most of the inefficient draft tubes and squabble over patents could have been prevented if there had been a thorough knowledge of what the early mechanics and water wheel builders of Massachusetts had already found out.

A young Canadian came into my office with two things on his mind, — a pair of water wheels to deliver 2,100 horsepower under a 30-foot head, which had fallen down, and a hockey team which had an

important series in Boston. Between the games he described the design of a pair of wheels, their setting and the results by test. The two wheels discharge against each other and are too near together, and also are set in a badly designed wheel case. The cross section of the wheel case of the first wheel of the pair was too small for the first and second wheel, the dome of the first wheel a bad obstruction, and with sharp corners everywhere. We got the setting redesigned, and the conditions of the contract met, with a somewhat homely revised setting. This was in 1911. Seven years later one of the principal water wheel catalogues showed a cut of an improved horizontal pair, with the efficiency of the pair as high as 88 per cent, which was about as good as the best of modern single vertical settings.

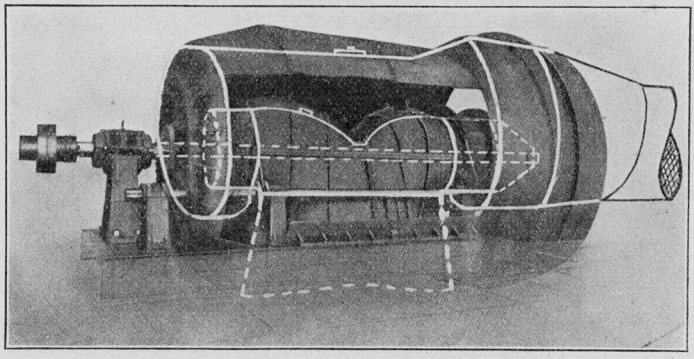


FIG. 28. — HORIZONTAL PAIR — CHANGES MADE IN HEAD-ON SETTING

Probably no subject has been discussed and even fought over in the courts more than the so-called patent draft tubes and quarter turns.

In 1897 the writer had occasion, with Mr. A. F. Sickman, to test out at Holyoke a single vertical and a horizontal pair of 30-inch Hercules B wheels, and found that the pair were too near together (twice the diameter). By adding an 8-inch ring at each end and increasing the distance apart to nearly three times, about four-fifths of the efficiency lost in the first setting was regained.

To avoid the interference of one wheel with another they should be four or five diameters apart; or, better, discharge away from each other into independent quarter turns.

Some of the most flagrant cases of bad design showed up in the setting of horizontal wheels in pairs for direct connected generators, or pulp grinders, at relatively high speed. The velocity leaving the wheels

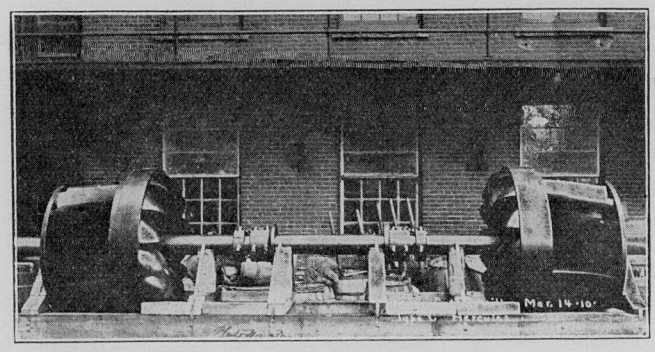


FIG. 29. — PAIR CENTRAL DISCHARGE HORIZONTAL WHEELS SPACED AS INSTALLED

was high, and if the two streams were opposed to each other, there was apparently much interference and the results were poor.

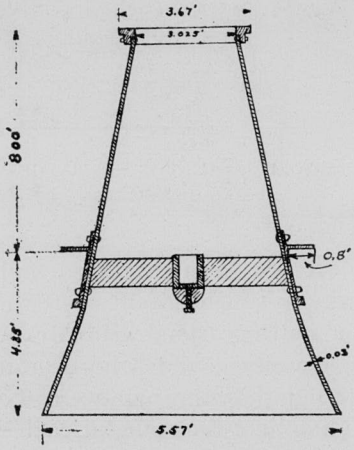


FIG. 30. — SWAIN EARLY TYPE DRAFT TUBE

It was many years before the proper shape of a quarter turn or draft tube was learned by the water-wheel builders, and yet in 1897 the Swain Turbine Company, with a 36-inch right-hand wheel tested

on a long conical draft tube, got about 85 per cent from 62.5 to 100.0 per cent gate, a part of this result above 80 per cent being due to the conical tube.

Design of Installations

If a hydraulic problem involves the expenditure of millions and the conditions are unusual, there are good reasons why much of the design should be tested out by models. Usually Federal or State projects

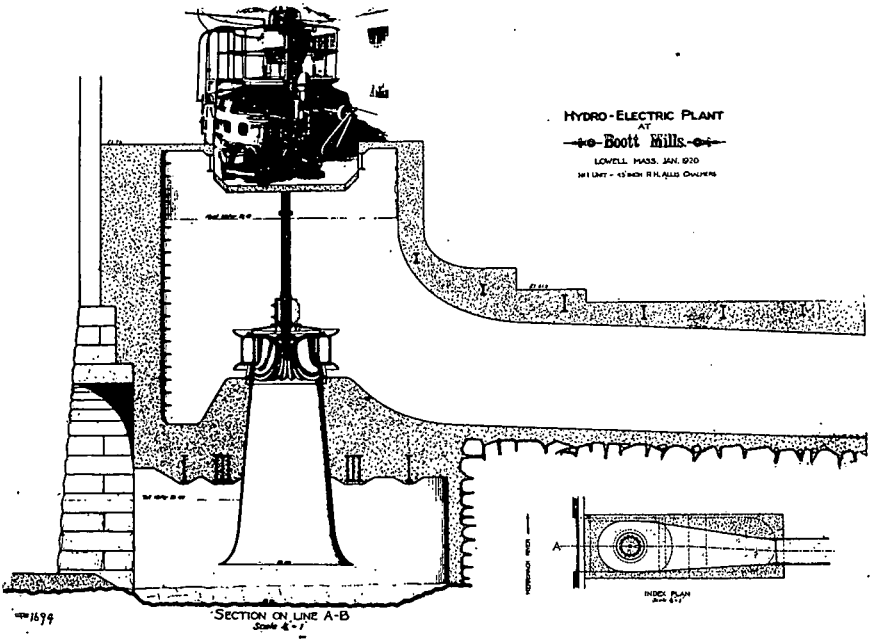


Fig. 31. — Hydro-Electric Plant at Boott Mills

are so big that no one engineer has had the experience to assume the responsibility alone, and many are consulted and tests of every kind made, but in New England structures are moderate in size, and the questions are usually more simple and well within the training and experience of many of our members. One knows what principles to use, what precautions to take, and the effect of obstructions, low and high water, back water and anchor ice.

The selection of the type of wheel and its performance is usually left to the water-wheel builder, and the design of the water channels to the hydraulic engineer, as it should be, if he is to take the responsi-

bility. In this field of work there is yet much to learn, perhaps because some very simple principles of hydraulics are either forgotten or the engineer has not seen water actually performing.

Experimental Data Voluminous

This brief description of the hydraulic experiments and tests made at Lowell and elsewhere, their value to the hydraulic engineer, and

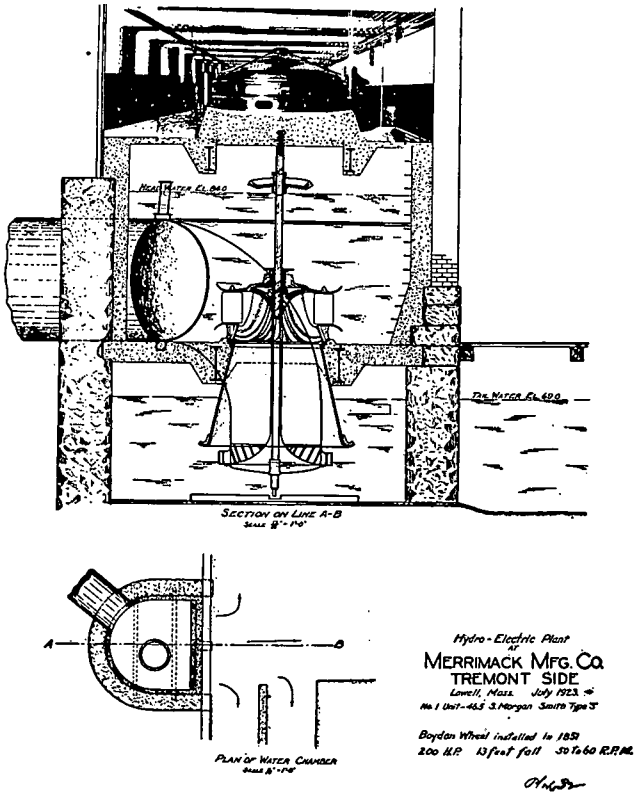


Fig. 32. — A Modern Setting in Original Wheel Pit

some of the practical questions which have been answered by the knowledge of the principles involved are a very small part of the present-day knowledge of hydraulics. Almost every publication of the engineering societies and the Federal and school laboratories contains some new group of experiments and the new or broader message which they con-

vey; but many of them are mathematical discussions and much involved, and do not convey the simple meaning of the early papers.

The "Transactions" of the American Society of Civil Engineers prior to 1900 are a hydraulic library in themselves, and the papers contributed by Francis, Herschel, Desmond FitzGerald, Fteley-Stearns and John R. Freeman include experiments, formulæ and rules for conducting experiments which have never been improved upon.

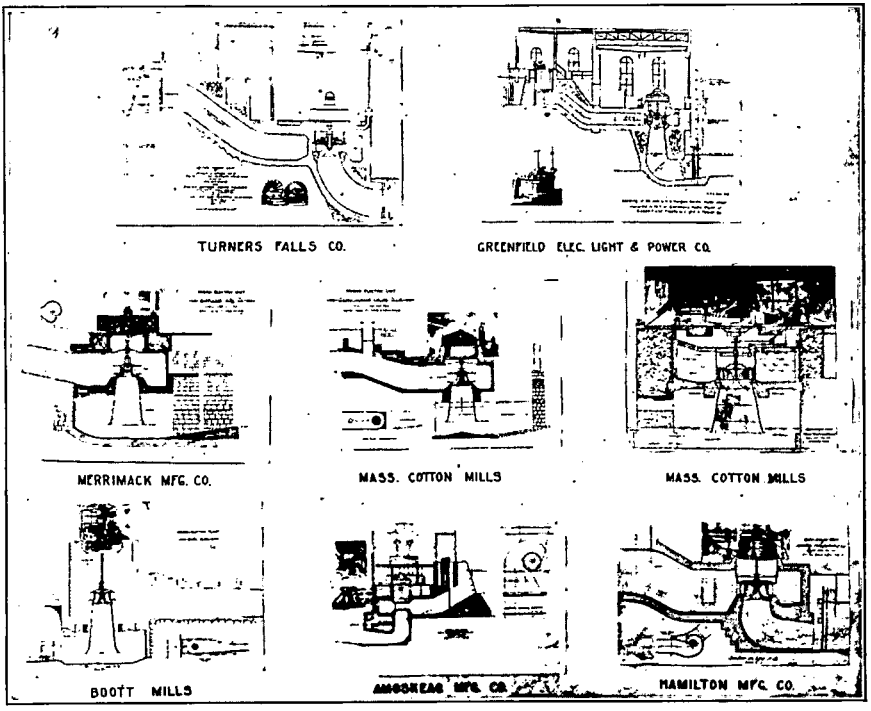


FIG. 33. — SOME MODERN VERTICAL SETTINGS

The principles involved in Mr. Francis' expanding tube are of inestimable value in the design of new plants.

I have used this valedictory address to honor some of the early hydraulic engineers, many of whom were masters or pupils of the Merrimack River school, and most of them early presidents of this society, to testify to the principles and accuracy which is characteristic of their experimental work, and to give some examples of what conditions are

most to be sought for in the design of hydraulic structures, whether water channels or settings for water wheels.

Experience without knowledge of fundamental principles, or theories without the means of trying them out, have their limitations. The country engineer like the country doctor may miss much of the finer knowledge of the specialist, but probably there will always be a place for him in the development of this country.

The young engineer, filled up as he is with examples of modern practice in engineering, may often miss the habit of thinking for himself by lack of attention to the simple hydraulic principles and easily understood experiments of the early hydraulic engineers. The modern and more specialized work may be as valuable but cannot take the place of the other.

UNITED STATES COAST AND GEODETIC SURVEY LEVELING IN NEW ENGLAND

By John B. Babcock, 3d,* Member

The recent publication of the results of a large amount of leveling in New England by the United States Coast and Geodetic Survey brings to civil engineers in this territory a valuable fund of information. During the past few years, United States Coast and Geodetic Survey leveling parties have been extending a network of precise levels throughout the New England States, most of the lines being first-order leveling with some second-order work in Maine. Descriptions and elevations of all bench marks on these lines have now been made available through the three following publications, obtainable from the Superintendent of Documents, Washington, D. C., at 10 cents each:

Special Publication No. 181 (U. S. C. and G. S.): "Leveling in Massachusetts, Rhode Island and Connecticut."
Special Publication No. 182 (U. S. C. and G. S.): "Leveling in New Hampshire and Vermont."
Special Publication No. 184 (U. S. C. and G. S.): "Leveling in Maine."

The Coast and Geodetic Survey has for its aim the establishment of permanent bench marks throughout the country on lines spaced not more than 25 miles apart. Bench marks are established at average intervals of two miles or less on the recent lines; on some of the earlier leveling the interval between bench marks was from three to five miles. At the present time large multiple-unit leveling parties are engaged in completing the "25-mile spacing" in the southern part of this territory, and it is probable that parties will be put in the field shortly to clear up the balance of this project in Vermont, New Hampshire and Maine. It is expected that by the middle of the present summer the necessary field work will have been completed so that very little of the territory in the New England States will be farther than twelve or fifteen miles from a United States Coast and Geodetic Survey bench mark of first or second order accuracy.

* Professor of Railway Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Leveling in Massachusetts, Rhode Island and Connecticut

Apparently the first attempt to place elevations in these States on a mean-sea-level datum by means of spirit leveling of high precision was made by the Commissioners of the Massachusetts Topographical Survey in 1893. C. H. Van Orden, an officer of the Coast and Geodetic Survey, was engaged to run a line of precise levels from Boston westward across Massachusetts into New York, via the route of the Boston & Albany Railroad, to a connection with the precise leveling which had previously been run along the east side of the Hudson River. The results of this leveling, including a detailed statement as to equipment and field methods, were included in the "Report of the Commissioners of the Massachusetts Topographical Survey, 1893." In 1915 the Boston & Albany Railroad ran a line of levels of considerable accuracy over the same route.

With the exception of a small amount of leveling of high precision carried out in 1916 by the Columbia University Summer School of Surveying, further precise leveling in these States was not undertaken until 1922, when the Coast and Geodetic Survey extended a line of first-order levels from Yonkers, New York, to Westerly, Rhode Island. In 1923, additional lines were run in these three States, including a line from Westerly, Rhode Island, through Boston to Portland, Maine. The Boston Society of Civil Engineers co-operated effectively with the Coast and Geodetic Survey in connection with the leveling in the vicinity of Boston, with the result that ties were made with the systems of the public utilities and the various municipalities. A description of this part of the work, with complete information as to the bench marks between Providence, Rhode Island, and Portland, Maine, was published in the Boston Society of Civil Engineers Journal, September, 1924. In 1927, through the co-operation of the Metropolitan District Water Supply Commission and the United States Coast and Geodetic Survey, a line was run from Springfield, Massachusetts, to Boston. Finally, in 1933, the Coast and Geodetic Survey re-ran the "Van Orden" line from Springfield to Albany, New York.

Fig. 1 shows the United States Coast and Geodetic Survey level network in Massachusetts, Rhode Island and Connecticut, which includes about 750 miles of first and second order leveling. The numbers on the diagram correspond to the lines indicated below:

Line 1.	Dover Plains, N. Y., to East Morris, Conn. (part)	1916
Line 2.	Yonkers, N. Y., to Westerly, R. I. (part)	1922
Line 3.	New Haven, Conn., to Springfield, Mass.	1923
Line 4.	New Britain to East Morris, Conn.	1923
Line 5.	Hartford, Conn., to Auburn, R. I.	1923
Line 6.	Westerly, R. I., to Boston, Mass.	1923
Line 7.	Portland, Maine, to Boston, Mass. (part)	1923
Line 8.	Boston, Mass., and vicinity (parts of several lines)	1923 and 1927
Line 9.	Springfield to Boston, Mass.	1927
Line 10.	Chicopee, Mass., to Bellows Falls, Vt. (part)	1927
Line 11.	Morris Station, via Torrington, to Thomaston, Conn.	1925 to 1932
Line 12.	Camp Columbia to Bantam, Conn.	1932
Line 13.	Morris Station, via Mount Tom, to Bantam, Conn.	1932
Line 14.	Springfield, Mass., to Troy, N. Y. (part)	1933

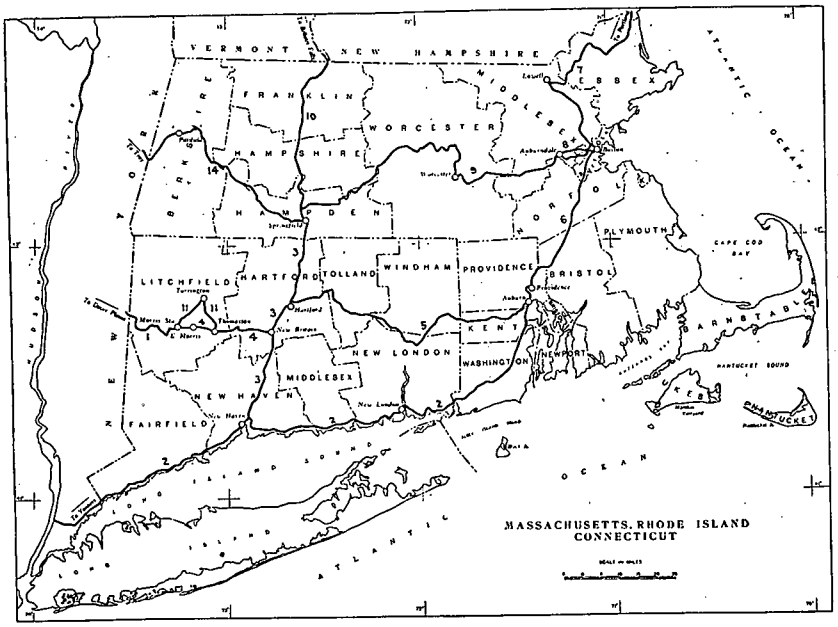


FIG. 1. — COAST AND GEODETIC SURVEY LEVEL NETWORK IN MASSACHUSETTS, RHODE ISLAND AND CONNECTICUT

Additional leveling in Massachusetts which has been done by other organizations is described on page 104

The leveling in the vicinity of Boston includes ties with the bench marks of the cities of Boston and Cambridge, tidal bench marks at the Charlestown Navy Yard and at the United States Navy Dry Dock at South Boston, and bench marks of the Boston & Maine, Boston & Albany, and New York, New Haven & Hartford Railroads. At the Massachusetts Institute of Technology a special bench mark carried down to bedrock by means of an 8-inch pipe filled with concrete was tied into the United States Coast and Geodetic Survey network.

Official bench marks of a number of important cities have been tied into the system. Among these are, in Connecticut: Stamford, South Norwalk, Bridgeport, New Haven, New London; in Rhode Island: Providence; in Massachusetts: Boston, Cambridge, Lowell, Springfield, Worcester, Holyoke.

Leveling by Massachusetts Department of Public Works, Local Control Survey, and Metropolitan District Water Supply Commission

The Massachusetts Department of Public Works has completed considerable first and second order leveling, the results of which are now being adjusted by the Coast and Geodetic Survey to make it a part of the nation-wide United States Coast and Geodetic Survey network. During the past year considerable second-order leveling has been done, and more is in progress under the Local Control Survey, which is an E. R. A. project in Massachusetts. This work is being done in co-operation with the Coast and Geodetic Survey. The Metropolitan District Water Supply Commission has completed some second-order leveling in addition to the first-order leveling which was done in co-operation with the Coast and Geodetic Survey in 1927.

The general location of the leveling carried out by the Massachusetts Department of Public Works, the E. R. A. Local Control Survey, the Metropolitan District Water Supply Commission, and the United States Coast and Geodetic Survey parties, which are now completing the "25-mile spacing" project in Massachusetts, is shown below. The descriptions and adjusted elevations of the bench marks established by the first-order leveling of the Coast and Geodetic Survey and the unadjusted elevations of the other circuits are available at the office of Mr. E. C. Houdlette, sixth floor, Public Works Building, 100 Nashua Street, Boston, Mass. (Special Publication No. 181 (U. S. C. and G. S.), "Leveling in Massachusetts, Rhode Island and Connecticut,"

contains the descriptions and adjusted elevations of the bench marks established in the first-order leveling of the Coast and Geodetic Survey.)

A large map showing the routes of all of the above leveling in Massachusetts is on file in the Library of the Boston Society of Civil Engineers, 715 Tremont Temple, Boston, Mass.

M. D. P. W. First-Order Levels:

Belmont to Lowell via Bedford; Bedford to Concord; Belmont to Weston; Weston to Ayer via Concord; Lowell to Ayer; Ayer to Greenfield via Leominster, Fitchburg, South Ashburnham, Gardner, Athol, Orange and Erving; Gardner to Winchendon; Athol to New Salem; Leominster to West Boylston and Oakdale.

M. D. P. W. Second-Order Levels:

Boston to Newburyport via Newburyport Turnpike; Boston to Newburyport via Lynn, Salem, Beverly and Ipswich; Beverly to Rockport; Woburn to Wilmington; Ashland to Lowell via Framingham and Concord; Boston to tip of Cape Cod at Provincetown via Quincy, Braintree, Brockton, Bridgewater, Middleborough, Wareham and Bourne; Bourne to Woods Hole; Pawtucket, R. I., to Worcester; Worcester to Palmer; Springfield to Deerfield via Westfield, Worthington and Ashfield; together with a large number of lines in southeastern Massachusetts connecting such points as Dedham, Norwood, Walpole, North Attleborough, Mansfield, Taunton, Brockton, Stoughton, Hingham, Kingston, Whitman, Plymouth and New Bedford.

M. D. W. S. C. Second-Order Levels:

Palmer to New Salem via Belchertown, Enfield and Greenwich Village; Old Furnace (Hardwick) to Greenwich Village.

E. R. A. Local Control Survey, Second-Order Levels (Completed or in progress):

Various lines in eastern Massachusetts, including lines (or parts of lines) from Boston to such points as Worcester, Lawrence, Newburyport, Gloucester, Fall River and Plymouth.

U. S. C. and G. S. Second-Order Levels (in progress):

Sheffield to Pownal (Vt.) via Pittsfield, Cheshire, Adams and North Adams; North Adams to Greenfield via Hoosac Tunnel, Shelburne Falls and Deerfield.

Leveling in New Hampshire and Vermont

Approximately 500 miles of first-order leveling have been run within the limits of these two States, as follows: New Hampshire, 100 miles; Vermont, 400 miles. Fig. 2 shows the United States Coast and Geodetic

Survey level network in New Hampshire and Vermont. The numbers on the diagram correspond to the lines indicated below:

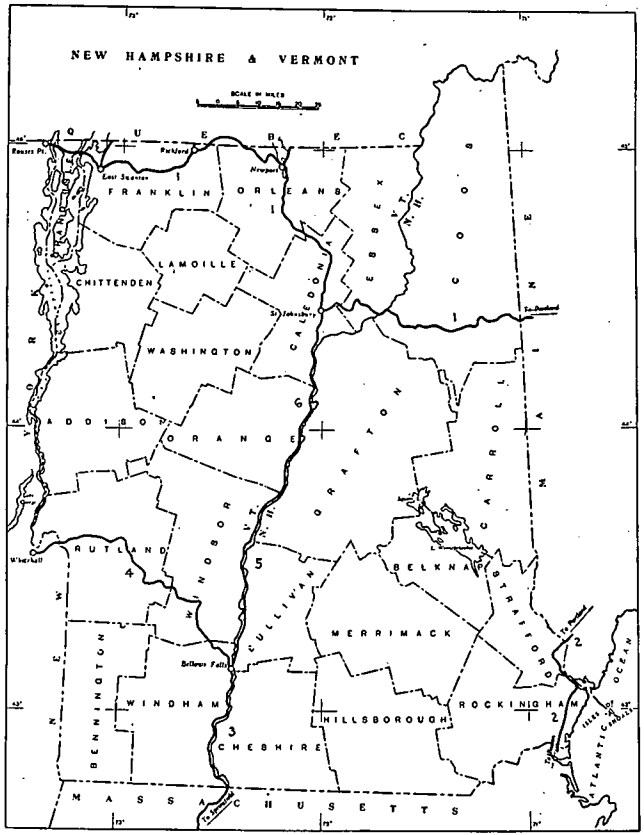
Line 1.	Rouses Point, N. Y., to Portland, Maine (part)	1922
Line 2.	Portland, Maine, to Boston, Mass. (part)	1923
Line 3.	Chicopee, Mass., to Bellows Falls, Vt. (part)	1927
Line 4.	Bellows Falls, Vt., to Whitehall, N. Y. (part)	1927
Line 5.	Bellows Falls to Thetford, Vt.	1927
Line 6.	St. Johnsbury to Thetford, Vt.	1927

Geodetic Survey of Canada Publication No. 17, "Precise Leveling in Quebec South of St. Lawrence River," contains information concerning additional bench marks along the northern border of Vermont.

Leveling in Maine

About 840 miles of first-order leveling and 470 miles of second-order leveling have been run in Maine. Fig. 2 shows the United States Coast and Geodetic Survey level network in this State. The numbers on the diagram correspond to the lines indicated below:

Line 1.	Boundary to Vanceboro, Maine	1916
Line 2.	Rouses Point, N. Y., to Portland, Maine (part)	1922
Line 3.	Portland, Maine, to Boston, Mass. (part)	1923
Line 4.	Calais to South Lagrange, Maine	1927
Line 5.	Fort Kent to South Lagrange, Maine	1927
Line 6.	Northern Maine Junction to Danville Junction, Maine	1927
Line 7.	Yarmouthville to Northern Maine Junction, Maine (second-order leveling)	1933
Line 8.	St. Croix Junction to Eaton, Maine (second-order leveling)	1933
Line 9.	Danforth to Houlton, Maine (second-order leveling)	1933
Line 10.	Houlton to Oakfield, Maine	1933
Line 11.	Somerset Junction to Oakland, Maine (second-order leveling)	1933
Line 12.	North Anson to Bethel, Maine (second-order leveling)	1933
Line 13.	Newry, Maine, to Jefferson Junction, N. H. (part) (second-order leveling)	1933



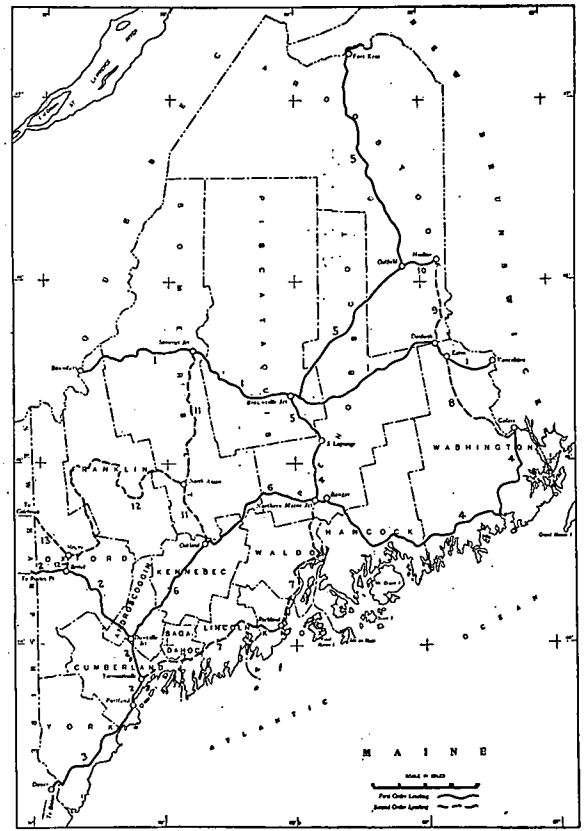


FIG. 2. — COAST AND GEODETIC SURVEY LEVEL NETWORK IN NEW HAMPSHIRE, VERMONT AND MAINE

United States Coast and Geodetic Survey Leveling

First-order leveling in New England by the Coast and Geodetic Survey was all run with instrumental equipment, either exactly alike or very similar to that described in United States Coast and Geodetic Survey Special Publication No. 129, "Geodetic Level and Rod." The field work was done in accordance with the instructions and specifications given in United States Coast and Geodetic Survey Special Publication No. 140, "Manual of First-order Leveling." The second-order leveling was run with the same instrumental equipment and under the same instructions as the first-order leveling, with the exception that a single running was permitted instead of the double running in opposite directions.

The computations and corrections for the United States Coast and Geodetic Survey leveling were carried to four decimal places in meters until the final elevations were derived, when they were rounded off to the nearest millimeter for publication. The elevations in feet were determined by converting the metric elevations, using the factor, 1 meter = 3.2808333 feet.

By 1929, so much additional leveling had been run throughout the United States that a new general adjustment was needed. The 45,000 miles of leveling in the United States, combined with about 20,000 miles of first-order leveling in Canada, was all adjusted in a single least-squares adjustment in which mean sea level was held at zero, as observed at 26 tidal stations (21 in the United States and 5 in Canada). The elevations resulting from the 1929 general adjustment are the best elevations obtainable from the data available at the time of adjustment.

United States Coast and Geodetic Survey standard bench-mark disks were set in existing structures, in concrete posts cast in place for the special purpose, and in outcrops of rock. In some cases disks are set vertically in walls. Engineers and others who have occasion to visit any bench marks established by the Coast and Geodetic Survey or by other governmental organizations will be doing a public service if they will report the conditions of the marks or make suggestions as to needed changes in the descriptions.

In extending its network of levels the Coast and Geodetic Survey makes a special effort to include bench marks recognized as part of other systems of leveling. These include particularly those established by the United States Engineers; United States Geological Survey; official bench marks of cities, of state departments of public works or other

organizations, and of railroads and other public utilities. Ties to other bench marks on the same mean-sea-level datum provide valuable checks on the leveling of these organizations. Ties to bench marks based on other than the mean-sea-level datum, particularly in the case of cities near the seaboard which adopted independent datum planes before the United States Coast and Geodetic Survey network was extended, are of great importance. The tying together of different systems makes it possible to study projects, such as extensive water supply systems involving several municipalities, without the necessity of running special lines of levels to secure elevations based on some common datum. The establishment of a complete system of bench marks throughout the United States based on the mean-sea-level datum is of great value to the civil engineering profession. When the desired aim has been reached of establishing such bench marks over the entire country, on lines spaced not over 25 miles apart, the Coast and Geodetic Survey will have completed a most important task. As stated earlier, this "25-mile spacing" will probably be completed throughout practically all of the New England States in the current year.

Of General Interest

PRIZES AWARDED AT ANNUAL MEETING, MARCH 20, 1935

The Desmond FitzGerald Medal

Presentation made by Richard K. Hale, Chairman of Committee on Award

The Desmond FitzGerald Medal was instituted and endowed in 1910 by the late Desmond FitzGerald, a Past President and Honorary Member of this Society, and is awarded annually for a paper presented to the Society by a member, and published during the year, which is adjudged worthy of special commendation for its merit. The Committee on Award this year, consisting of S. Stanley Kent, J. Stuart Crandall and myself, selected from the list of a number of excellent papers one which was recommended to the Board of Government for the award. The paper selected was entitled "Mechanics of Hydraulic-Fill Dams," by Dr. Glennon Gilboy, Member, presented at a meeting of the Society held on May 16, 1934, and published in the JOURNAL of the Society, July, 1934. On behalf of the Board of Government I take great pleasure in presenting the Desmond FitzGerald Medal to Dr. Glennon Gilboy.

Dr. Gilboy expressed his appreciation of the high honor bestowed upon him by the presentation of this medal.

The Sanitary Section Prize

Presentation by Prof. Gordon M. Fair, Member of Sanitary Section Prize Committee

The Committee on Prize Award for the Sanitary Section consisted of Gen. Richard K. Hale, C. Frederic Joy and Prof. Gordon M. Fair. Professor Fair, on behalf of the Board of Government, very pleasingly presented the prize to Arthur L. Shaw, Member, for his paper entitled "The Newton High-Level Sewer," read at a meeting of the Sanitary Section on March 7, 1934, and published in the JOURNAL of April, 1934. The prize consisted of books, —Kent's "Mechanical Engineers Handbook" and "Waterworks Handbook," by Flinn, Weston and Bogert. Mr. Shaw in accepting this prize referred to his pleasure and the interest of his associates in carrying on the project described in the paper.

The Clemens Herschel Prize

Award Announced by the President, Arthur T. Safford

The Clemens Herschel Prize was provided for by the late Clemens Herschel, a Past President and Honorary Member of the Society. The prize consists of a copy of a book written by the donor and entitled "Frontinus and the Water Supply of the City of Rome," and is awarded each year for a paper which has been practically useful and worthy of recognition.

The President stated that this year the prize had been awarded to Dr. Leo Jürgenson, who was Research Associate at Massachusetts Institute of Technology in 1934, but who has now returned to Estonia, Europe. He presented a paper before the Designers Section May 9, 1934, on "The Application of Theories of Elasticity and Plasticity to Foundation Problems," published in the JOURNAL for July, 1934. The President announced that the author was not present to receive the prize, but that it had been forwarded to the recipient. Subsequently Dr. Jürgenson sent a letter to the Society in appreciation of the honor of receiving the prize.

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

Boston Society of Civil Engineers

FEBRUARY 20, 1935. — A regular meeting of the Boston Society of Civil Engineers was held this evening in the Engineers' Club, and was called to order at 7 P.M., by the President, Arthur T. Safford. Eighty-five members and guests were present. Sixty-three persons attended the buffet supper preceding the meeting.

The President announced the death of John H. Griffin, on January 10, 1935, who had been a member since January 27, 1915.

The Secretary reported the names of the following who had been elected to membership on February 20, 1935:

Grade of Student: Henry R. Cattley, Harry F. Johnson, Frederick P. Moran, John C. Rizya, U. M. Schiavone.

The President introduced Mr. Elmer C. Houdlette, Massachusetts representative of the United States Coast and Geodetic Survey, who gave an interesting talk on "E. R. A. Local Control Surveys Under the Jurisdiction of the United States Coast and Geodetic Survey," illustrated with diagrams and charts. An informal question period followed the talk. The meeting adjourned at 8.45 P.M.

EVERETT N. HUTCHINS, *Secretary.*

MARCH 20, 1935. — The eighty-seventh annual meeting of the Boston Society of Civil Engineers was held today at the Boston Chamber of Commerce and was called to order by the President, Arthur T. Safford, at 4.30 P.M.

The minutes of all previous meetings of the year which have been printed in the various issues of the JOURNAL were declared approved as printed.

The President announced the death of the following members:

John B. Graham, who died January 12, 1935, and had been a member since June 19, 1907; William E. McKay, who died March 2, 1935, and had been a member

since October 16, 1895; John W. Morrison, who died December 9, 1934, and had been a member since February 17, 1896; Prof. Dwight Porter, who died February 26, 1935, and had been a member since November 18, 1885; Eugene E. Pettee, who died March 16, 1935, and had been a member since November 18, 1896.

The Secretary reported that the following had been elected to membership by the Board of Government on March 20, 1935:

Grade of Member: Gail P. Edwards, Forrest P. Harbour.

Transferred from grade of Junior to Member: J. A. Komich.

Grade of Junior: Domenic Capone, Henry A. Phillips.

The annual reports of the Board of Government, Treasurer, Secretary and Auditor were presented. Also reports were made by the following committees: Membership and Publicity, Social Activities, Relation of Sections to Main Society, Welfare, Library, Registration and Licensing of Engineers, Run-off and Subsoils of Boston.

Voted, That the reports be accepted with thanks and placed on file, and that they be printed in the April, 1935, JOURNAL.

Voted, That the incoming Board of Government be authorized to appoint such committees as it deems desirable.

The report of the Tellers of Election, S. Stanley Kent and Truman H. Safford, was presented, and in accordance therewith the President declared the following had been elected officers for the ensuing year:

President — Prof. John B. Babcock, 3d.
Vice-President (for two years) — Raymond W. Coburn.
Secretary — Everett N. Hutchins.
Treasurer — Karl R. Kennison.
Directors (for two years) — Albert Haertlein, J. Stuart Crandall.
Members of Nominating Committee (for two years) — Stuart E. Coburn, Glennon Gilboy, Arthur P. Rice.

The retiring President then delivered his annual address on "Merrimack Valley Hydraulic Engineers."

This was illustrated by lantern slides.

The meeting adjourned to assemble at 7.30 P.M., the annual dinner being held during the interim.

The President then called the meeting to order for the presentation of prizes.

He requested General Richard K. Hale, Chairman of the Committee on Award of the Desmond FitzGerald Prize, to present the Desmond FitzGerald Medal to Dr. Glennon Gilboy for his paper on "Mechanics of Hydraulic Fill Dams," presented at a meeting of the Society, held on May 16, 1934, and published in the JOURNAL of July, 1934.

The President called upon Prof. Gordon N. Fair, a member of the Committee on Award of the Sanitary Section Prize, to present the Sanitary Section prize to Arthur L. Shaw for his paper on "The Newton High-Level Sewer," presented at a meeting of the Sanitary Section, March 7, 1934, and printed in the April, 1934, JOURNAL. The prize consisted of books, — Kent's "Mechanical Engineers Handbook" and "Waterworks Handbook," by Flinn, Weston and Bogert.

The President announced that the Board of Government had awarded the Clemens Herschel Prize — a copy of the book "Frontinus and the Water Supply of the City of Rome," by the late Clemens Herschel — to Dr. Leo Jürgenson for his paper on "The Application of Theories of Elasticity and Plasticity to Foundation Problems," presented at a meeting of the Designers Section held on May 9, 1934, and published in the July, 1934, JOURNAL. He stated that he regretted the author was not here to receive the prize personally; however, the prize is being sent to him in Estonia, Europe.

The President expressed his appreciation of the honor of serving as President of the Society, and with best wishes for success turned the affairs of the Society over to his successor, the new President, Prof. John B. Babcock, 3d.

A program of entertainment, including music, readings and humorous sketches, was enjoyed after the dinner.

Eighty-six members and guests attended the dinner.

The meeting adjourned at 9 o'clock.

EVERETT N. HUTCHINS, *Secretary.*

Sanitary Section

MARCH 6, 1935. — The Annual Meeting of the Sanitary Section of the Boston Society of Civil Engineers was held on March 6, 1935.

Twenty-seven members and guests attended dinner at Patten's Restaurant at 6 P.M.

The meeting was called to order in the Society Rooms at 7.15 P.M., with forty-two members and guests present.

The report of the Nominating Committee, consisting of Messrs. Edward Wright, Ralph W. Horne and Stuart E. Coburn, was accepted, and the following officers were elected for the ensuing year:

Chairman — Frank L. Flood.
Vice-Chairman — Paul F. Howard.
Clerk — Richard S. Holmgren.
Executive Committee — Thomas R. Camp, Ralph M. Soule, Samuel M. Ellsworth.

Dr. H. Peters, Instructor in Fluid Mechanics, Massachusetts Institute of Technology, gave an interesting talk on "The Law of Fluid Flow through Pipe Lines."

The meeting adjourned at 9.15, after an interesting discussion led by George E. Russell, Professor of Hydraulics, Massachusetts Institute of Technology.

PAUL F. HOWARD, *Clerk.*

Designers Section

FEBRUARY 13, 1935. — The Designers Section of the Boston Society of Civil Engineers met in the Society rooms, Tremont Temple, on Wednesday evening, February 13, 1935, at 6.30 P.M. This was a joint meeting with the Highway Section.

This being the meeting preceding the Annual Meeting, which requires the election of a Nominating Committee, it was voted to instruct the Chairman to appoint a Nominating Committee to report at the Annual Meeting on March 13. The Chairman appointed Messrs. William D. Henderson, Lawrence G. Ropes and Frederic N. Weaver, Chairman.

Mr. F. D. Sabin, a District Highway Engineer of the Massachusetts Department of Public Works, presented a paper describing "The New Cambridge–Concord Highway." Mr. J. E. Lawrence, also a District Highway Engineer of the Massachusetts Department of Public Works, gave an illustrated talk on the "Improvements on the Newburyport Turnpike at Newburyport." These two papers described two notable achievements in highway design and construction.

Ninety members and guests were present.

The meeting adjourned at 8.55 P.M.

ALBERT HAERTLEIN, *Clerk.*

MARCH 13, 1935. — The annual meeting of the Designers Section of the Boston Society of Civil Engineers was held on March 13, 1935, at the Society rooms, 715 Tremont Temple. Chairman W. W. Bigelow called the meeting to order at 6.30 P.M.

The minutes of the February meeting and the annual report of the Executive Committee were read and accepted.

Prof. Frederic N. Weaver, Chairman of the Nominating Committee, read the report of the Committee. The Chairman called for additional nominations.

Voted, That the nominations be closed and that the Clerk be instructed to cast one written ballot for the slate as read.

The new officers for the coming year are as follows:

Chairman — Henry Brask.
Vice-Chairman — Albert Haertlein.
Clerk — Anthony S. Coombs.
Executive Committee — John B. Wilbur, Herman G. Dresser, Elmer P. Rankin.

Mr. John R. Nichols, Consulting Engineer, led "A Discussion of the Proposed Building Law for Boston." Both the law as presented in House Bill No. 1135 and the Building Code Regulations were discussed.

Voted, That it is the sense of this meeting of the Designers Section of the

Boston Society of Civil Engineers that we favor House Bill No. 1135 and urge its passage.

There were present thirty-two members and guests.

The meeting adjourned at 8.45 P.M.

ALBERT HAERTLEIN, *Clerk.*

APRIL 10, 1935. — A meeting of the Designers Section of the Boston Society of Civil Engineers was held in the Society Rooms, April 10, 1935, and was called to order by the Chairman, Henry Brask, at 6.35 P.M.

The minutes of the annual meeting held March 13, 1935, were read and approved.

The speaker was Mr. Arthur C. Ruge, Research Associate in Seismology, Massachusetts Institute of Technology. Mr. Ruge presented a very instructive and interesting talk concerning "The Effects of Earthquakes on Elevated Water Tanks as Determined by Model Studies." The talk was illustrated with slides, and a demonstration was given of the action of earthquake forces, using a shaking table carrying a model representing an elevated water tank. The demonstration illustrated the action of the tank alone and when placed on top of a building. The action of the building frame alone was also shown. Interest in the talk was indicated by the discussion which followed.

Mr. Ruge was given a rising vote of thanks in appreciation of his talk.

The attendance was seventeen, and the meeting adjourned at 8.55 P.M.

ANTHONY S. COOMBS, *Clerk.*

Highway Section

FEBRUARY 13, 1935. — The Annual Meeting of the Highway Section of the Boston Society of Civil Engineers was held jointly with the Designers Section on February 13, 1935, at the Society rooms, 715 Tremont Temple. Chairman Haertlein called the meeting to order at 6 P.M.

The minutes of the previous meeting and the annual report of the Executive Committee were read and accepted.

The Nominating Committee reported the following nominations for officers of the Section for the year 1935–36:

Chairman — G. A. Graves.
Vice-Chairman — A. Casagrande.
Clerk — A. J. Bone.
Executive Committee — W. S. Carson, A. P. Rice, W. F. Baker.

The report of the Nominating Committee was accepted and the Chairman authorized to instruct the Clerk to cast one ballot for all officers as submitted.

Chairman Haertlein then introduced Mr. F. D. Sabin, a District Highway Engineer of the Massachusetts Department of Public Works, who spoke on "The New Cambridge–Concord Highway."

Following Mr. Sabin's address the Chairman introduced the second speaker, Mr. J. E. Lawrence, also a District Highway Engineer of the Massachusetts Department of Public Works, who gave an illustrated talk on "Improvements on the Newburyport Turnpike at Newburyport."

A brief discussion period followed; the meeting adjourned at 7.45 P.M. The attendance was 85.

A. J. BONE, *Clerk.*

Northeastern University Section

FEBRUARY 19, 1935. — The meeting was called to order at 7 P.M. by J. N. De Serio, Chairman. There were eleven students and six guests present.

Announcement of the proposed Section Journal was made and Wilfred C. Pitts, 1936, offered to help with it. An announcement was also made to the effect that if sufficient interest is shown the Section will sponsor an Engineering Excursion to New York City in the spring. Mr. De Serio brought to the attention of the Section the bill now pending in the State Legislature regarding the registration of engineers and architects.

A Nominating Committee to act upon Division A officers for the coming year was appointed by the Chairman. The Committee is to report at the next meeting. Those appointed are: Francis

J. Flynn, 1936, Ernest L. Spencer, 1936, and Ralph F. D'Elis, 1937.

Mr. Edward T. Hartman, State Consultant on Planning, was the guest speaker of the evening. His topic was "Municipal Planning." Highlights of his talk follow:

"Planning is the endeavor to do things right. It is not a study of disorganization, rather a study of organization. The first point to be sure of is its *social utility*."

In the development of his points, Mr. Hartman used many illustrations of both poor and good planning. He especially flayed the roadside development along the Worcester Turnpike, and the East Boston Tunnel. Examples of good planning, he stated, are those at Cincinnati, Ohio, and Springfield, Massachusetts. According to Mr. Hartman, an active and intelligent planning board should be one of the most important units of municipal government.

Following a discussion period, coffee and sandwiches were served, to take the place of a supper, which has preceded earlier meetings.

KENNETH F. KNOWLTON, *Clerk*.

APPLICATIONS FOR MEMBERSHIP

[April 20, 1935]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of fifteen (15) days from the date given.

For Admission

KELLEY, EDWARD F., Arlington, Mass. (Age 40, b. Somerville, Mass.) Education: graduate, Arlington High School, 1913; course in mechanical engineering at Lowell Institute, 1933–35. Experience: 1916–19, United States Navy, petty officer, 1st class, assigned to United States Naval Gun Factory at Washington, D. C., on computations, and assisted in design of afterbody of torpedo; 1919–20, civil service junior engineer, Small Arms Division of Ordnance, Washington, D. C.; 1920–22, American Zinc Company, of St. Louis, Mo., design, layout and drafting on zinc oxide plant; dismantling plant at Caney, Kans.; 1922–29, assistant to chief engineer, Shell Petroleum Corporation, Tulsa, Okla.; served on Committee of American Petroleum Institute, standardization of oil field equipment, inspection, reports, design of new equipment and construction; 1929–32, chief engineer for Wertzberger Derrick and Equipment Company, Tulsa, Okla., in charge of all design, manufacturing, construction and purchase of materials; 1933–35, assistant to executive director in charge of engineering division, Emergency Planning and Research Bureau; September, 1934, to January, 1935, with Fay, Spofford & Thorndike as engineering inspector of driven well system at Sterling, Mass.; now assistant to executive director, Emergency Planning and Research Bureau. Refers to *F. M. Gunby, J. H. Harding, R. W. Horne, I. E. Moultrop.*

MOORE, DWIGHT HERRICK, Huntington, Mass. (Age 28, b. Huntington, Mass.) Graduated from Huntington High School. Attended civil engineering course for three years at Worcester Polytechnic Institute, Worcester, Mass. Since March, 1930, senior engineering aid, Massachusetts Department of Public Works. Refers to *A. B. Appleton, R. W. Coburn, G. A. Graves, F. T. McAvoy.*

O'HEARN, JAMES A., Cambridge, Mass. (Age 28, b. Cambridge, Mass.) Educa-

tion: graduate, 1923, and postgraduate, 1924, Rindge Technical School, Cambridge; scholarship at Massachusetts Institute of Technology for two years, 1925 and 1926. Experience: 1926–29, with Erastus Worthington, Dedham, as instrument man and chief of party on general civil engineering; 1929–31, with United States government, Division of Surveys, Panama Canal, as engineer (civil service); in charge of preliminary work for Madden Dam; constructed Naval Air Base at Coco Solo, C. Z.; in command of cruise of U. S. S. "Favorite," building lighthouses on islands in Pacific Ocean; 1931, appointed by President Hoover to Inter-American Highway Commission; made location of California–Panama Highway across Costa Rica; private contract with War Department for engineering work on Army Airport, Balboa, C. Z.; 1931–32, appointed hydrographer on Carpelan–East Indies Expedition, on two-year scientific cruise through South Seas and around the world, mapping floor of oceans, currents, etc.; cruise ended at Galapagos Islands; 1932, traffic engineer, city of Cambridge, on traffic survey; 1933, appointed first chief of party on United States Coast and Geodetic Survey, E. R. A. project, under E. C. Houdlette, Boston; 1934, United States Engineers, War Department, Army Base, Boston, engineer in charge of harbor defences to establish coast artillery fire control systems for Boston and New Bedford harbors; 1934, to present time, assistant administrator of E. R. A. State Planning Board in charge of engineering work in devising, planning and promoting E. R. A. work projects throughout Massachusetts. Refers to *J. B. Babcock, 3d, S. M. Ellsworth, J. H. Harding, Erastus Worthington.*

ADDITIONS

Junior

Domenic Capone, 58 Barnes Avenue, East Boston, Mass.

Students

Henry R. Cattley, 32 Irving Street, Melrose, Mass.

John C. Rizya, 116 Everett Avenue, Chelsea, Mass.

DEATHS

John B. Graham . .	Jan. 10, 1935
Capt. William E. McKay	Mar. 2, 1935
John W. Morrison . .	Dec. 9, 1934
Eugene E. Pettee . .	Mar. 16, 1935
Dwight Porter . . .	Feb. 26, 1935

Annual Reports

Report of Board of Government for the Year 1934–35

Boston, March 20, 1935.

To the Boston Society of Civil Engineers:

Pursuant to the requirements of the By-Laws, the Board of Government presents its report for the year ending March 20, 1935.

Membership

Six new members, no juniors and 23 students have been added during the year and two members have been reinstated, making a total addition of 31 members.

During the year 21 members have died, 18 have resigned, 3 have forfeited membership for non-payment of dues, and 13 have had dues remitted and resignations accepted, making a total deduction of 55.

The present membership of the Society consists of 5 honorary members, 698 members, 145 juniors, 12 associates, 1 member of the Sanitary Section only, and 77 student members, making a total membership of 938, a net loss for the year of 24.

The honorary membership list now is as follows:

Charles T. Main, elected January 28, 1932.
Dr. Karl T. Compton, elected February 17, 1932.
Prof. C. Frank Allen, elected March 16, 1932.
Harrison P. Eddy, elected February 21, 1934.
Joseph R. Worcester, elected February 21, 1934.

Deaths

George C. Ambrose, July 18, 1934.
Henry H. Carter, October 4, 1934.
George W. Fuller, June 18, 1934.
John B. Graham, January 12, 1935.
John H. Griffin, January 10, 1935.
George W. Hamilton, April 6, 1934.
Frederic M. Hersey, January 20, 1935.
Howard C. Holden, December 21, 1934.
George L. Hosmer, January 11, 1935.
Frank F. Jonsberg, June 14, 1934.
Arthur D. Marble, April 30, 1934.
William E. McKay, March 2, 1935.
John W. Morrison, December 9, 1934.
Theodore P. Perkins, March 28, 1934.
Eugene E. Pettee, March 16, 1935.
Dwight Porter, February 26, 1935.
Frederic P. Spalding, October 29, 1934.
Henry T. Stiff, November 27, 1934.
George E. Stuart, August 20, 1934.
James H. Sullivan, April 4, 1934.
Herbert A. Wilson, May 7, 1934.

Remission of Dues and Extension of Time

For members who have not paid the current year's dues, for the year ending March, 1935, the Board has remitted dues for 4 members and granted an extension of time for 76 members. For members who owe two years' dues, *i.e.*, for years ending in March, 1934, and March, 1935, the Board has remitted their dues for the year ending March, 1934, for 120 members, and granted to the same members an extension of time in which to pay dues for the year ending March, 1935. In summary, the Board has granted an extension of time for 196 members to pay dues for the year ending March, 1935.

Exemption of Dues

Eighty-one members are now exempt from dues in accordance with By-Law 8, which provides that "a member of any grade who has paid dues for forty years, or who has reached the age of seventy years and has paid dues for thirty years, shall be exempt from further dues.

Meetings of the Society

Eight regular meetings, since the Annual Meeting, have been held during the year, and a joint outing with the New England Water Works Association on June 27, 1934, at the Salem Country Club, Peabody. An excursion was taken to view the work on the new highway bridges across the Cape Cod Canal in October.

The average attendance at the meetings of the Society was 90, the largest being 225 and the smallest 40. Buffet suppers have been a feature of all the meetings. The papers and addresses given were as follows:

March 21, 1934. — Annual meeting. Address of retiring President, Arthur W. Dean, "One Factor of Highway Transport," followed by dinner, smoker and entertainment.

April 16, 1934. — "Taxation," by Hon. Henry S. Long, Commissioner of Taxation and Corporations.

May 16, 1934. — "Mechanics of Hydraulic Fill Dams," by Glennon Gilboy, Sc.D., Associate Professor of Soil Mechanics, Massachusetts Institute of Technology.

September 26, 1934. — "The Use of Reinforced Concrete Rigid Frame Bridges in Grade Crossing Eliminations," by R. R. Zipprodt, Regional Structural Engineer, Portland Cement Association.

October 20, 1934. — Excursion to new Highway Bridges at the Cape Cod Canal.

November 21, 1934. — "Little Bay and Bellamy River Bridges in Dover, New Hampshire," by Prof. Charles M. Spofford, Professor of Civil Engineering, Massachusetts Institute of Technology.

December 19, 1934. — "Foundation of the Boston, Massachusetts, Parcel Post Building," by Harry E. Sawtell, member of firm, Chas. T. Main, Inc.

January 23, 1935. — "Construction Progress on Boulder Dam," by Charles R. Gow, President, Warren Brothers Company.

February 20, 1935. — "E. R. A. Local Control Surveys Under the Jurisdiction of the United States Coast and Geodetic Survey," by Elmer C. Houdlette, Massachusetts Representative of the United States Coast and Geodetic Survey.

Sections

Twenty-four meetings were held by the Sections of the Society during the year. These meetings of the Sections, offering opportunity for less formal discussion, have continued to demonstrate their value to their members and to the Society. The

variety of subjects presented has made an appeal to the members, as indicated by the general attendance at these meetings.

Sanitary Section Meetings. — The Sanitary Section has held 4 meetings during the year, with an average attendance of 44. The papers and meetings are listed in the report of the executive committee. Present membership, 194.

Designers Section Meetings. — The Designers Section has held 8 regular meetings during the year. The average attendance has been 48. The papers and meetings are listed in the report of the executive committee. Present membership, 169.

Highway Section Meetings. — The Highway Section has held 4 regular meetings during the year, with an average attendance of 32. Present membership, 96.

Northeastern University Section. — The Northeastern University Section has held 8 meetings during the year, with an average attendance of 22. Present total membership, 233, of which 46 are in attendance at the University.

Journal

The complete report of the Editor of the JOURNAL for the calendar year 1934 will be printed in the April JOURNAL.

*Funds of the Society**

Permanent Fund. — The Permanent Fund of the Society has a present value of nearly $50,000. The Society again authorized the use of the current income of this fund, amounting to $2,321.07, in payment of current expenses.

John R. Freeman Fund. — In 1925 the late John R. Freeman, a Past President and honorary member of the Society, made a gift to the Society of securities which was established as the John R. Freeman Fund, the income of which was about $1,300. The income from this fund is to be particularly devoted to the encouragement of young engineers. Mr. Freeman suggested several uses, such as the payment of expenses for experiments and compilations to be reported before the Society; for underwriting meritorious books or publications pertaining to hydraulic science or art; or a portion to be devoted to a yearly prize for the most useful paper relating to hydraulics contributed to this Society; or establishing a traveling scholarship every third year open to members of the Society for visiting engineering works, reports of which would be presented to the Society.

Leslie J. Hooper, assistant in hydraulic engineering at Worcester Polytechnic Institute, was selected by the John R. Freeman Fund Committee to receive the scholarship for the year beginning July, 1934.

Edmund K. Turner Fund. — In 1916 the Society received 1,105 books from the library of the late Edmund K. Turner and a bequest of $1,000, "the income of which is to be used for library purposes." The Board voted on February 20, 1935, to use as much of the income as necessary for permanent binding of volumes in the library.

Alexis H. French Fund. — The Alexis H. French Fund, a bequest amounting to $1,000, was received in 1931 from the late Alexis H. French of Brookline, a former Past President of the Society. The income of this fund is "to be devoted to the library of the Society." None of the income from this fund has been used during the year.

Desmond FitzGerald Fund. — The Desmond FitzGerald Fund, established as a bequest from the late Desmond FitzGerald, a Past President and honorary member of

* Details regarding the values and income of these funds are given in the Treasurer's report.

the Society, provides that the income from this fund shall "be used for charitable and educational purposes." The board voted on January 24, 1934, to appropriate from the income of this fund the sum of $100, to be known as the Boston Society of Civil Engineers Scholarship in memory of Desmond FitzGerald, and to be given to a student at Northeastern University. Presentation of the scholarship was made by Vice-President Arthur D. Weston at a student meeting at the University in May, 1934, to James N. DeSerio, a student in civil engineering. This year, on January 23, 1935, the Board voted to award a scholarship which will be presented to the selected student at a special meeting of the students to be held at an early date at the University.

Tinkham Memorial Fund. — The "Samuel E. Tinkham Fund," established in 1921 at the Massachusetts Institute of Technology by the Society "to assist some worthy student of high standing to continue his studies in civil engineering," had a value of $2,463.23 on June 30, 1934. Mr. Kasmierz J. Winiarski of New Bedford, a student in civil engineering in the class of 1935 at Technology, has been awarded this scholarship for the year 1934–35.

Attention is called to the fact that the tuition at the Massachusetts Institute of Technology is now $500 per year, whereas the annual income from the Tinkham Fund is about $135. Additional donations for this fund would make it of greater service for the purpose for which it was established.

Clemens Herschel Fund. — This fund was established in 1931 by a bequest from the late Clemens Herschel, a former Past President and honorary member of the Society. The income from this fund is to be used for the presentation of prizes for particularly useful and commendable papers presented at meetings of the Society. The present value of this fund is about $1,000. The expenditure made during the year from this fund was for prizes.

Edward W. Howe Fund. — This fund, a bequest of $1,000, was received December 2, 1933, from the late Edward W. Howe, a former Past President of the Society. No restrictions were placed upon the use of this money, but the recommendation of the Board of Government is that the fund be kept intact, and that the income be used for the benefit of the Society or its members. No expenditure was made during the year.

Desmond FitzGerald Medal

The Desmond FitzGerald Medal (bronze) was provided for in 1910 as an endowed prize by the late Desmond FitzGerald, a former Past President and honorary member of the Society. This prize is awarded annually to a member who presents an original paper to the Society which is published in the JOURNAL for the current year.

In accordance with the recommendation of the Committee on Awards, the Board of Government voted to award the Desmond FitzGerald medal to Glennon Gilboy, member, for his paper on "Mechanics of Hydraulic-Fill Dams," presented at a meeting of the Society on May 16, 1934, and published in the JOURNAL of the Society for July, 1934.

Section Prizes

The Board of Government voted on April 12, 1924, "to present a prize for a worthy paper given in each section by a member of that section," this award to consist of books suitably inscribed.

Sanitary Section Prize. — The Board adopted the recommendation of the Sanitary Section Prize Committee and voted, February 20, 1935, that the Sanitary Section Prize

be awarded to Arthur L. Shaw, member, for his paper on "Newton High Level Sewer," presented at a meeting of the Sanitary Section on March 7, 1934, and published in the April, 1934, JOURNAL.

Clemens Herschel Award

The late Clemens Herschel, a former Past President and honorary member, gave to the Society a number of copies of his book on "Frontinus and the Water Supply of the City of Rome," with the request that the Board award one or more of the books each year as prizes for papers which have been particularly useful and commendable and worthy of grateful acknowledgment.

On recommendation of the Desmond FitzGerald Committee on Awards, the Board voted to present a copy of this book to Leo Jürgenson for his paper on "The Application of Theories of Elasticity and Plasticity to Foundation Problems," presented at a meeting of the Designers Section on May 9, 1934, and published in the July, 1934, JOURNAL.

Social Activities

Six of the regular meetings of the year have been held at the Engineers' Club and one meeting at Chipman Hall, Tremont Temple, preceded by buffet suppers, under the direction of the Social Activities Committee. As usual, the most enthusiastic meeting was student night, held in November, and attended by members of the Student Engineering Societies of Massachusetts Institute of Technology, Harvard, Tufts and Northeastern University, at which time representatives of the musical clubs of the latter school assisted in the entertainment. An excursion was taken to view the work at the new highway bridges over the Cape Cod Canal, on October 20, 1934, which was attended by fifty members and guests.

Library

The Report of the Committee on Library contains a complete account of the library activities during the past year.

Society Activities

The usual special committees dealing with the general activities and conduct of the Society have included the following: Program, Publication, Library, Social Activities and Membership and Publicity. Other special committees have included the following: Subsoils of Boston, Run-off, Research, Registration and Licensing of Engineers, Relation of Sections to the Main Society, Desmond FitzGerald and other prizes and John R. Freeman Fund and Welfare Committee. Each of these committees has made a distinct contribution to the Society and has developed fields of endeavor which will prove of great benefit to the members.

The Society has co-operated with the Engineering Societies of New England, and many members of the Society have served on Engineering Societies' committees.

Your Board, in conclusion, wishes to express its appreciation of the excellent work done by the officers of the Sections and by the committees of the Society.

ARTHUR T. SAFFORD, *President.*

Report of the Treasurer

BOSTON, March 10, 1935.

To the Boston Society of Civil Engineers:

The finances of the Society are set forth in three appended tables: Table 1, presenting the receipts and expenditures on account of the Society's eight funds; Table 2, recording its investments and the income therefrom; and Table 3, summarizing the present distribution of its assets.

All interest and dividends from the Permanent Fund were transferred to the Current Fund. The sum of $1,000 was returned and added to the principal of the Permanent Fund. The following is a brief statement of current expenditures, year by year, and shows the extent to which they have been met by the transfer of Permanent Fund income:

	1930-31	1931-32	1932-33	1933-34	1934-35
Net expenditures (except such as provided for by appropriations from other than Permanent Fund income)	$9,443	$10,086	$8,734	$7,228	$7,609
Members' dues received	8,028	7,045	6,030	5,540	5,390
Deficit	$1,415	$3,041	$2,704	$1,688	$2,219
Income from Permanent Fund:					
Net transfer to Current Fund	$2,647	$2,664	$2,489	$2,262	$1,321
Added to Permanent Fund principal	–	–	–	–	1,000

Unexpended income from the investments in funds other than the Permanent Fund has accumulated as follows:

John R. Freeman Fund	$1,119 26
Edmund K. Turner Fund	–
Desmond FitzGerald Fund	112 16
Alexis H. French Fund	65 55
Clemens Herschel Fund	99 57
Edward W. Howe Fund	44 07

All securities are now carried on the books at their market value instead of cost, and their appreciation or depreciation since the date of purchase is shown in Table 2. Such net gain or loss, not including securities disposed of in previous years, is as follows:

Permanent Fund	$−4,517
John R. Freeman Fund	−10,496
Edmund K. Turner Fund	+100
Desmond FitzGerald Fund	−258

Recent changes in the value of the Society's principal funds are as follows:

	March 1, 1931	March 10, 1932	March 10, 1933	March 10, 1934	March 10, 1935
Permanent Fund	$53,457	$46,488	$42,937	$46,029	$46,891
John R. Freeman Fund	31,231	23,278	17,667	17,759	16,503
Other investment funds	–	–	–	5,728	6,169

During the last fiscal year the earnings of the Permanent Fund were at the average rate of 5.0 per cent; of the John R. Freeman Fund, 7.6 per cent; of other investment funds, 4.3 per cent; the total being $3,888.

The total value of all assets is $70,891.03, not including the value of the library and furniture, which has been carried on the books for the last eighteen years at $9,905.11. There are no liabilities.

Respectfully submitted,

KARL R. KENNISON, *Treasurer.*

TABLE 1. — RECEIPTS AND EXPENDITURES

Current Fund

Receipts

Balance March 10, 1934	$2,225 85
Transferred from Permanent Fund income	2,321 07
Transferred from Edmund K. Turner Fund income	63 02
Transferred from Alexis H. French Fund income	58
Transferred from Clemens Herschel Fund income	18 90
Received from Secretary as shown in his account	6,542 72
	$11,172 14

Expenditures

Returned to Permanent Fund principal	$1,000 00
Distributed as shown in Secretary's account	8,841 08
Bank taxes	3 20
Balance March 10, 1935	1,327 86
	$11,172 14

Permanent Fund

Receipts

Balance March 10, 1934 — Investments		$50,348 07
Returned from Current Fund		1,000 00
Income from investments:		
Interest:		
Bonds	$1,034 96	
Co-operative banks	525 38	
Savings banks	210 13	
Dividends	550 60	
Total interest and dividends		2,321 07
Entrance fees		60 00
		$53,729 14

Expenditures

Income transferred to Current Fund		$2,321 07
Depreciation of investments since purchase		4,516 63
Balance March 10, 1935:		
Investments (see Table 2)	$48,400 21	
Cash	—1,508 77	
		46,891 44
		$53,729 14

John R. Freeman Fund

PRINCIPAL ACCOUNT

No change, except depreciation of investments since purchase		$10,496 38
Balance March 10, 1935:		
Investments (see Table 2)	$15,347 50	
Cash	36 12	
		$15,383 62

INTEREST ACCOUNT

Receipts

Balance March 10, 1934	$1,022 47
Dividends	1,310 29
	$2,332 76

Expenditures

Traveling scholarships	$1,213 50
Balance March 10, 1935	1,119 26
	$2,332 76

Edmund K. Turner Fund

Principal Account

No change, except appreciation of investments since purchase		$100 00
Balance March 10, 1935:		
Investments (see Table 2)	$1,093 75	
Cash	6 25	
		$1,100 00

Interest Account

Receipts

Balance March 10, 1934	$13 02
Interest — Bond	50 00
	$63 02

Expenditures

Transferred to Current Fund	$63 02

Desmond FitzGerald Fund

Principal Account

No change, except depreciation of investments since purchase	$257 50
Balance March 10, 1935 — Investments (see Table 2)	1,747 50

Interest Account

Receipts

Balance March 10, 1934	$112 16
Interest — bonds	100 00
	$212 16

Expenditures

Northeastern University scholarship	$100 00
Balance March 10, 1935	112 16
	$212 16

Alexis H. French Fund

Principal Account

No change. Additional investment of accrued interest		$31 13
Balance March 10, 1935:		
Investments (see Table 2)	$1,061 36	
Cash	—61 36	
		$1,000 00

Interest Account

Receipts

Balance March 10, 1934	$35 00
Interest — savings bank	31 13
	$66 13

Expenditures

Transferred to Current Fund	$0 58
Balance March 10, 1935	65 55
	$66 13

Clemens Herschel Fund

Principal Account

No change. Additional investment of accrued interest		$36 54
Balance March 10, 1935:		
Investments (see Table 2)	$1,071 84	
Cash	—71 84	
		$1,000 00

Interest Account

Receipts

Balance March 10, 1934	$81 93
Interest — Savings bank	36 54
	$118 47

Expenditures

Transferred to Current Fund	$18 90
Balance March 10, 1935	99 57
	$118 47

Edward W. Howe Fund

Principal Account

No change. Additional investment of cash	$132 37
Balance March 10, 1935 — Investments (see Table 2)	1,000 00

Interest Account

Receipts

Balance March 10, 1934	$4 67
Interest — Co-operative banks	39 40
	$44 07

Expenditures

None.	
Balance March 10, 1935	$44 07

Table 2. — Record of Investments

Permanent Fund

	Maturity or Classification	Current Interest Rate	During the Fiscal Year			Gain or Loss Since Purchase	March 10, 1935		
			Interest or Dividends	Additional Investment	Received at Sale or Maturity		Amount or Number of Shares	Value	Cost
Bonds									
American Tel. & Tel. Co.	Dec. 1, 1946	5 %	$50 00	–	–	+$100 00	1,000	$1,093 75	$993 75
Arkansaw Water Co.	Oct. 1, 1956	5 %	50 00	–	–	+30 00	1,000	1,035 00	1,005 00
The Boston Terminal Co.	July 1, 1950	4 %	24 00	$1,000 00	–	+40 00	1,000	1,040 00	1,000 00
California Water Service Co.	Apr. 1, 1958	5 %	18 47	972 78	–	+52 22	1,000	1,025 00	972 78
Chicago & Northwestern Ry. Co.	Nov. 1, 1987	5 %	50 00	–	–	−645 00	1,000	457 50	1,102 50
Connecticut River Power Co.	Oct. 1, 1952	5 %	73 89	–	$2,089 20	+161 70	–	–	–
Consolidated Gas Co. of N. Y.	June 1, 1951	4½%	48 75	2,000 36	–	+74 64	2,000	2,075 00	2,000 36
Houston Lighting & Power Co.	June 1, 1981	4½%	24 37	980 28	–	+74 72	1,000	1,055 00	980 28
Illinois Power & Light Corp.	Dec. 1, 1956	5 %	50 00	–	–	−148 75	1,000	832 50	981 25
Kansas Power & Light Co.	Feb. 1, 1947	6 %	60 00	–	–	+115 00	1,000	1,030 00	915 00
Louisiana Power & Light Co.	Dec. 1, 1957	5 %	50 00	–	–	+110 00	1,000	945 00	835 00
Mississippi Power & Light Co.	Dec. 1, 1957	5 %	50 00	–	–	−173 75	1,000	798 75	972 50
The New Rochelle Water Co.	Nov. 1, 1951	5½%	24 44	945 00	–	+30 00	1,000	975 00	945 00
Pacific Gas & Electric Co.	June 1, 1960	4½%	24 25	1,000 00	–	+62 50	1,000	1,062 50	1,000 00
Pennsylvania Power & Light Co.	Apr. 1, 1981	4½%	61 87	957 63	–	+134 87	2,000	2,062 50	1,927 63
The Pennsylvania Railroad Co.	June 1, 1965	4½%	24 37	1,017 74	–	+51 01	1,000	1,068 75	1,017 74
Public Electric Light Co.	Oct. 1, 1956	5½%	110 00	–	–	−55 00	2,000	1,920 00	1,975 00
Southern Pacific Co.	Mar. 1, 1977	4½%	45 00	–	–	−195 00	1,000	760 00	955 00
Tennessee Public Service Co.	Oct. 1, 1970	5 %	50 00	–	–	−182 50	1,000	820 00	1,002 50
The Toledo Edison Co.	Nov. 1, 1962	5 %	34 44	2,085 00	–	+67 50	2,000	2,152 50	2,085 00
Wheeling Electric Co.	May 1, 1941	5 %	111 11	–	4,207 65	+362 65	–	–	–
Total, Bonds	– –	–	$1,034 96	$10,958 79	$6,296 85	+$66 81	–	$22,208 75	$22,666 29

TABLE 2. — RECORD OF INVESTMENTS — *Continued*

PERMANENT FUND — *Concluded*

	Maturity or Classification	Current Interest Rate	During the Fiscal Year			Gain or Loss Since Purchase	March 10, 1935		
			Interest or Dividends	Additional Investment	Received at Sale or Maturity		Amount or Number of Shares	Value	Cost
Co-operative Banks									
Merchants Co-operative Bank	Dec. 1939	4 %	$114 00	$474 00	–	–	30 Ser. 140	$2,976 00	
Volunteer Co-operative Bank	Jan. 1936	4½%	187 00	487 00	–	–	25 Ser. 135	4,467 00	
Volunteer Co-operative Bank	Mat. Shrs.	4 %	80 00	–	–	–	10	2,000 00	
Watertown Co-operative Bank	Mat. Shrs.	3½%	70 00	–	–	–	10	2,000 00	
Watertown Co-operative Bank	Mat. Shrs.	3½%	58 38	267 63	$4,600 00	–	–	–	
Suffolk Co-operative Bank	Feb. 1940	4 %	16 00	1,083 80	–	–	10 Ser. 134	1,083 80	
Total, Co-operative Banks	– –	–	$525 38	$2,312 43	$4,600 00	–	–	$12,526 80	$12,526 80
Savings Banks									
Eliot Savings Bank, Boston	– –	3 %	$116 56	$116 56	–	–	–	$3,674 65	
Lynn Five Cents Savings Bank	– –	3 %	93 57	93 57	–	–	–	3,189 64	
Total, Savings Banks	– –	–	$210 13	$210 13	–	–	–	$6,864 29	$6,864 29
Stocks									
American Tel. & Tel. Co.	– –	$9 00	$414 00	–	–	–$435 54	46	$4,910 50	$5,346 04
Consolidated Gas Co. of N. Y.	Com.	1 00	45 00	–	–	–1,566 50	20	340 00	1,906 50
General Electric Co.	– –	60	12 00	–	–	–323 70	20	452 50	790 07
Radio Corporation of America	Com.	–	–	–	$1 93		3	13 87	
New England Power Assoc.	Pref.	4 00	60 00	–	–	–550 00	10	295 00	845 00
New York Central R.R. Co.	– –	–	–	–	13 80	–736 70	10	133 75	870 45

North American Trust	Cum. 1955	104	19 60	–	–	−419 00	200	346 00	765 00
United States Steel Co.	Com.	–	–	–	–	−552 00	10	308 75	860 75
Total, Stocks	– –	–	$550 60	–	$15 73	−$4,583 44	–	$6,800 37	$11,383 81
Cash	– –	–	–	–	–	–	–	−1,508 77	−1,508 77
Total, Permanent Fund	– –	–	$2,321 07	$13,481 35	$10,912 58	−$4,516 63	–	$46,891 44	$51,932 42

John R. Freeman Fund

Stocks									
Alabama Power Co.	Cum. Pref.	$7 00	$70 00	–	–	−$480 00	10	$500 00	$980 00
American Superpower Corp.	Pref'nce	–	–	–	–	−1,770 00	20	170 00	1,940 00
Carolina Power & Light Co.	Cum. Pref.	7 00	43 80	–	–	−460 00	10	560 00	1,020 00
Commonwealth & Southern Corp.	Cum. Pref.	6 00	48 00	–	–	−725 14	8	276 00	1,019 89
Commonwealth & Southern Corp.	Com.	–	–	–	–		25	18 75	
Consumers Power Co.	Cum. Pref.	6 00	60 00	–	–	−190 00	10	830 00	1,020 00
Electric Power & Light Corp.	Cum. Pref. 7%	–	–	–	–	−1,017 45	10	42 50	1,076 20
Electric Power & Light Corp.	Com.	–	–	–	–		10	16 25	
Georgia Power Co.	Cum. Pref.	6 00	84 00	–	–	−338 33	14	805 00	1,143 33
Minnesota Power & Light Co.	Pref.	5 25	48 10	–	–	−490 00	10	490 00	980 00
Mississippi River Power Co.	Cum. Pref.	6 00	60 00	–	–	−40 00	10	860 00	900 00
Montreal Light, Heat & Power Cons.	Com.	1 50	93 70	–	–	+416 32	66	1,914 00	1,497 68
New England Power Assoc.	Pref.	4 00	60 00	–	–	−675 00	10	295 00	970 00
New England Power Co.	Pref.	6 00	60 00	–	–	+40 00	10	1,000 00	960 00
Northwestern Electric Co.	Cum. 1st Pr.	–	–	–	–	−770 00	10	210 00	980 00
Pacific Gas & Electric Co.	Cum. 1st Pr. 6%	1 50	90 00	–	–	−339 52	60	1,215 00	1,922 02
Pacific Gas & Electric Co.	1st Pr. 5½%	1 375	27 52	–	–		20	367 50	
Pacific Gas & Electric Co.	Com.	1 50	96 00	–	–	−928 79	64	880 00	1,808 79
Penn. Gas & Elec. Corp.	Pref.	7 00	210 00	–	–	−1,185 00	30	1,770 00	2,955 00
Southern Cal. Edison Co.	Cum. Orig. Pr.	1 75	75 00	–	–	+28 78	40	1,190 00	1,161 22
Southern Cal. Edison Co.	Com.	1 50	32 50	–	–	−312 25	20	227 50	539 75
The Tenn. Elec. Power Co.	1st Pref.	7 00	70 00	–	–	−490 00	10	460 00	950 00

TABLE 2. — RECORD OF INVESTMENTS — *Continued*

JOHN R. FREEMAN FUND — *Concluded*

	Maturity or Classification	Current Interest Rate	During the Fiscal Year			Gain or Loss Since Purchase	March 10, 1935		
			Interest or Dividends	Additional Investment	Received at Sale or Maturity		Amount or Number of Shares	Value	Cost
Stocks — Con.									
Utah Power & Light Co.	Cum. Pref.	$4 67	$11 67	–	–	–$800 00	10	$190 00	$990 00
West Penn. Power Co.	Cum. Pref.	7 00	70 00	–	–	+30 00	10	1,060 00	1,030 00
Total, Stocks	– –	–	$1,310 29	–	–	–$10,496 38	–	$15,347 50	$25,843 88
Cash:									
Principal account	– –	–	–	–	–	–	–	36 12	36 12
Interest account	– –	–	–	–	–	–	–	1,119 26	1,119 26
Total, John R. Freeman Fund	– –	–	$1,310 29	–	–	–$10,496 38	–	$16,502 88	$26,999 26

EDMUND K. TURNER FUND

American Tel. & Tel. Co.	Dec. 1, 1946	5 %	$50 00	–	–	+$100 00	1,000	$1,093 75	$993 75
Cash — Principal account	– –	–	–	–	–	–	–	6 25	6 25
Total, Edmund K. Turner Fund	– –	–	$50 00	–	–	+$100 00	–	$1,100 00	$1,000 00

Desmond FitzGerald Fund

Central Power & Light Co.	Aug. 1, 1956	5 %	$50 00	–	–	–$267 50	1,000	$737 50	$1,005 00
Southwestern Gas & Elec. Co.	Jan. 1, 1957	5 %	50 00	–	–	+10 00	1,000	1,010 00	1,000 00
Total, Bonds	– –	–	$100 00	–	–	–$257 50	–	$1,747 50	$2,005 00
Cash — Interest account	– –	–	–	–	–	–	–	112 16	112 16
Total, Desmond FitzGerald Fund	– –	–	$100 00	–	–	–$257 50	–	$1,859 66	$2,117 16

Alexis H. French Fund

Boston Five Cents Savings Bank	– –	3 %	$31 13	$31 13	–	–	–	$1,061 36	
Cash:									
Principal account	– –	–	–	–	–	–	–	–61 36	
Interest account	– –	–	–	–	–	–	–	65 55	
Total, Alexis H. French Fund	– –	–	$31 13	$31 13	–	–	–	$1,065 55	$1,065 55

Clemens Herschel Fund

Charlestown Five Cents Savings Bank	– –	3½%	$36 54	$36 54	–	–	–	$1,071 84	
Cash:									
Principal account	– –	–	–	–	–	–	–	–71 84	
Interest account	– –	–	–	–	–	–	–	99 57	
Total, Clemens Herschel Fund	– –	–	$36 54	$36 54	–	–	–	$1,099 57	$1,099 57

TABLE 2. — RECORD OF INVESTMENTS — *Concluded*

EDWARD W. HOWE FUND

	Maturity or Classification	Current Interest Rate	During the Fiscal Year			Gain or Loss Since Purchase	March 10, 1935		
			Interest or Dividends	Additional Investment	Received at Sale or Maturity		Amount or Number of Shares	Value	Cost
Suffolk Co-operative Bank	Mat. Shrs.	4 %	$32 15	$1,000 00	–	–	5	$1,000 00	
Watertown Co-operative Bank	Mat. Shrs.	3½%	7 25	–	$867 63	–	–	–	
Total, Co-operative Banks	– –	–	$39 40	$1,000 00	$867 63	–	–	$1,000 00	
Cash — Interest account	– –	–	–	–	–	–	–	44 07	
Total, Edward W. Howe Fund	– –	–	$39 40	$1,000 00	$867 63	–	–	$1,044 07	$1,044 07

ALL FUNDS

Total, Investment Funds	– –	–	$3,888 43	$14,549 02	$11,780 21	–$15,170 51	–	$69,563 17	$85,258 03
Cash in Current Fund	– –	–	–	–	–	–	–	1,327 86	1,327 86
Total, Funds	– –	–	–	–	–	–	–	$70,891 03	$86,585 89

TABLE 3. — DISTRIBUTION OF ASSETS, MARCH 10, 1935

	Current Fund	Investments							Total
		Permanent Fund	John R. Freeman Fund	Edmund K. Turner Fund	Desmond FitzGerald Fund	Alexis H. French Fund	Clemens Herschel Fund	Edward W. Howe Fund	
Bonds	–	$22,208 75	–	$1,093 75	$1,747 50	–	–	–	$25,050 00
Co-operative banks	–	12,526 80	–	–	–	–	–	$1,000 00	13,526 80
Savings banks	–	6,864 29	–	–	–	$1,061 36	$1,071 84	–	8,997 49
Stocks	–	6,800 37	$15,347 50	–	–	–	–	–	22,147 87
Cash:									
Principal account	–	–1,508 77	36 12	6 25	–	–61 36	–71 84	–	–1,599 60
Interest account	$1,327 86	–	1,119 26	–	112 16	65 55	99 57	44 07	2,768 47
Total Funds	$1,327 86	$46,891 44	$16,502 88	$1,100 00	$1,859 66	$1,065 55	$1,099 57	$1,044 07	$70,891 03

REPORT OF AUDITING COMMITTEE FOR YEAR 1934–35

BOSTON, March 16, 1935.

We have examined the accounts of the Treasurer of the Boston Society of Civil Engineers and find the books properly kept and the various expenditures of the past year supported by duly approved receipts.

The Treasurer has also accounted to us for the investments and cash on hand, as submitted in the above report.

In this audit we have had the benefit of the services of Hartshorn & Walter, Certified Public Accountants.

HARRY P. BURDEN,
FRANK B. WALKER,
Auditing Committee of the Directors of the Boston Society of Civil Engineers.

Report of the Auditor

MARCH 19, 1935.

Auditing Committee, Boston Society of Civil Engineers, Room 715, Tremont Temple, Boston, Massachusetts:

In accordance with the vote of the Board of Government of the Boston Society of Civil Engineers at its meeting held on May 16, 1934, we have made an examination of the financial records of this Society for the fiscal year ended March 10, 1935. The scope of our examination was as follows:

Securities held by the Society as at March 10, 1935, were examined. Market values of these securities as at close of the security markets on March 9, 1935, were listed by us and used by your Treasurer in his report. Purchases and sales of securities during the fiscal year ended March 10, 1935, were verified by examination of broker's statements and votes authorizing same.

The recorded receipts of the Treasurer were properly accounted for. The receipts from your Secretary as recorded by the Treasurer were checked to the Secretary's records. Expenditures made by the Treasurer were verified by examination of cancelled checks and vouchers as approved by your President.

The receipts and disbursements of the various funds during the fiscal year ended March 10, 1935, and the balances as at March 10, 1935, were checked to statement as compiled by your Treasurer, a copy of which is attached hereto.

During the course of our examination we noted that although your fiscal year ended March 10, 1935, certain receipts and expenditures of the Current Fund as included in that fiscal year were dated as late as March 14, 1935. The assets as shown in your Treasurer's report do not reflect the balance in the Secretary's bank account, amounting to $105.40, as at the close of the fiscal year.

Respectfully submitted,

HARTSHORN & WALTER.

Report of the Secretary

BOSTON, March 15, 1935.

To the Boston Society of Civil Engineers:

The following is a statement of cash received by the Secretary, and of the expenditures approved by the President, in accordance with the budget adopted by the Board of Government for the year ending March 20, 1935:

	Current Fund Account		Cash Receipts	Credit Transfers by Treasurer	Net Distribution under Budget	
	Account Number	Expenditures			Expenditures	Receipts
Office:						
Secretary — salary and expense	(1)	$240 00	–	–	–	–
Stationery, printing and postage	(2)	269 19	–	–	–	–
Incidentals and petty cash	(3)	86 58	–	–	–	–
Insurance and Treasurer's bond	(4)	41 03	–	–	–	–
Safety deposit box	(5)	11 00	–	–	–	–
Prizes	(6)	18 90	–	$18 90*	–	–
Quarters, rent, light, services, telephone	(7)	1,012 16	$350 00†	–	–	–
Office, clerical	(8)	840 00	–	–	–	–
Total		$2,518 86	$350 00	$18 90	$2,149 96	–
Meetings:						
Rent of halls, etc.	(11)	$152 20	–	–	–	–
Stationery, printing and postage	(12)	192 75	–	–	–	–
Social activities	(13)	46 97	$1 25	–	–	–
Steriopticon	(15)	20 05	–	–	–	–
Annual meeting (March, 1934)	(16)	121 50	–	–	–	–
Total		$533 47	$1 25	–	$532 22	–

* From Clemens Herschel Fund.

† Engineering Societies of New England.

REPORT OF THE SECRETARY — *Concluded*

	Current Fund Account		Cash Receipts	Credit Transfers by Treasurer	Net Distribution under Budget	
	Account Number	Expenditures			Expenditures	Receipts
Sections:						
Sanitary Section	(21)	$10 70	–	–	–	–
Designers Section	(22)	31 75	–	–	–	–
Highway Section	(23)	14 00	–	–	–	–
Northeastern University Section	(24)	11 00	–	–	–	–
Total		$67 45	–	–	$67 45	–
Journal:						
Editor — salary and expense	(31)	$304 00	–	–	–	–
Printing and postage	(32)	2,861 11	–	–	–	–
Reprints	(33)	27 75	–	–	–	–
Advertising, commission, etc.	(34)	162 35	$544 00	–	–	–
Sale of Journals	(35)	–	203 30	–	–	–
Total		$3,355 21	$747 30	–	$2,607 91	–
Library:						
Librarian — salary and expense	(41)	$100 86	–	–	–	–
Periodicals	(43)	80 50	–	–	–	–
Binding	(44)	63 60	–	$63 60*	–	–
Total		$244 96	–	$63 60	$181 36	–
Library fines		–	$7 25	–	–	$7 25
Miscellaneous:						
Badges for members	(51)	$26 00	27 25	–	–	1 25
Binding JOURNALS for members	(52)	22 00	20 00	–	$2 00	–

Engineering Societies of Boston	(59)	2,073 13	–	–	2,073 13	–
Dues	(70)	–	5,389 67	–	–	5,389 67
Income from Permanent Fund		–	–	$2,321 07†	–	2,321 07
Grand Total		$8,841 08	$6,542 72	$2,403 57	$7,614 03	$7,719 24
Other accounts, Permanent Fund:						
Entrance fees, 6 new members at $10		–	$60 00	–	–	$60 00
Secretary's cash fund, First National Bank of Boston		–	$105 40	–	–	$105 40

* From Turner and French Funds. † From Permanent Fund.

The above cash receipts, except Secretary's cash fund, have been paid to the Treasurer, whose receipt the Secretary holds.

Respectfully submitted,

EVERETT N. HUTCHINS, *Secretary.*

Report of the Editor

BOSTON, February 15, 1935.

To the Board of Government, Boston Society of Civil Engineers:

The JOURNAL for the calendar year 1934 (Volume XXI) was issued quarterly, in the months of January, April, July and October, as authorized by the Board of Government on December 20, 1933.

During the year 1934 there have been published twelve papers, presented at meetings of the Society and Sections; four other technical articles; a printing of the Constitution and By-Laws of the Society and Sections, and the Rules applying to the awards of the Desmond FitzGerald Medal and other prizes, in the April issue. The Contents and Index for this year are included in the January, 1935, issue.

The four issues of the JOURNAL contained 359 pages of papers and discussions, 24 pages of advertising, a total of 383 pages. An average of 1,291 copies per issue were printed. The net cost was $2,071.37, as compared with $1,308.36 for the preceding year.

Table I includes a comparison of the costs for the JOURNAL from 1930 to 1934, inclusive. In Table II details of cost for Volume XXI of the JOURNAL for the calendar year 1934 are shown.

Respectfully submitted,

EVERETT N. HUTCHINS, *Editor.*

TABLE I. — COMPARISON OF COSTS OF JOURNAL, 1930–34, INCLUSIVE

Year	Volume	Number of Pages*	Gross Cost†		Net Cost‡		Number of Cuts and Inserts
			Total	Per Page	Total	Per Page	
1930 . . .	XVII	723	$5,107 16	$7 06	$3,812 86	$5 27	167
1931 . . .	XVIII	515	3,916 95	7 60	2,634 18	5 11	99
1932 . . .	XIX	633	3,906, 87	6 17	2,600 62	4 10	108
1933 . . .	XX	331	2,265 51	6 84	1,380 36	4 17	82
1934 . . .	XXI	383	2,966 67	7 74	2,071 37	5 43	126

* Includes Advertising Section.

† Gross cost, included editing, printing and mailing.

‡ Net cost equals gross cost less amounts received for advertising, subscriptions and sales of JOURNALS.

TABLE II. — 1934 JOURNAL, VOLUME XXI

	Issues of —				
	January	April	July	October	Total
Number of pages:					
Papers and discussion	60	124	103	72	359
Advertising and advertisers' index	6	6	6	6	24
Total pages	66	130	109	78	383
Number of cuts	22	23	45	36	126
Cost of Journal					
Composition and printing	$349 14	$687 70	$578 21	$397 42	$2,003 47
Cuts	109 42	90 85	196 85	153 84	550 96
Wrapping, mailing and postage	–	–	–	–	109 24
Editing	–	–	–	–	295 00
Copyright	–	–	–	–	8 00
Total gross cost of JOURNAL	–	–	–	–	$2,966 67

Receipts from subscriptions and sales of JOURNALS and reprints	$197 75	
Receipts (net) from advertising	697 55	
Total receipts		895 30
Net cost of JOURNAL		$2,071 37

Report of the Committee on Membership and Publicity

BOSTON, March 16, 1935.

To the Boston Society of Civil Engineers:

The Committee on Membership and Publicity has continued to hold itself in readiness to perform any duties that would be assigned to it. At the same time, it has kept in touch with the membership and publicity committees of the Engineering Societies of New England by means of conferences, at which the Committee was represented by its chairman and by correspondence. An effort is being made by the Engineering Societies of New England to devise ways and means of strengthening the membership of the individual societies as well as the affiliation. No definite plans have as yet been determined.

It is gratifying to note that, in spite of economic conditions, thirty-one new members have been received into the Society during the year.

Respectfully submitted,

For the Committee,

A. B. EDWARDS, *Chairman.*

Report of the Committee on Social Activities

BOSTON, March 20, 1935.

To the Boston Society of Civil Engineers:

The Committee on Social Activities submits the following report for the year 1934–35.

At the six regular meetings at the Engineers' Club, held during the past year, an average of 57 members and guests per meeting were served with buffet suppers. The smallest number served was 37 and the largest 71.

One hundred and thirteen members and guests attended the annual dinner at the Chamber of Commerce Building.

On the excursion to the Cape Cod Canal bridges, 45 attended the buffet lunch at Bourne.

One hundred and ninety-four were served at the November meeting which was designated as student night.

As in past years, the June meeting was combined with the annual outing of the New England Water Works Association, which was held at the Salem Country Club. About 180 members and guests, including ladies, attended.

The charge for buffet suppers has been 50 cents, the same as during the past year.

At the January meeting, held in Chipman Hall, the caterer served the food at tables, thus obviating the procession through the kitchen. This innovation was a distinct improvement and seemed to please those who attended.

It is gratifying to note that there has been a larger attendance than for some time past at the last three regular meetings. We sincerely hope that this attendance will continue to increase.

Respectfully submitted,

JOHN H. HARDING, *Chairman.*

Report of the Committee on Relation of Sections to the Main Society

BOSTON, March 20, 1935.

To the Boston Society of Civil Engineers:

This Committee was established to co-ordinate the activities of the Society and of its Sections — the Sanitary, Designers, Highway and Northeastern University Sections. Its personnel includes the four Section chairmen, together with one or more members to represent the main Society.

The Committee provides a ready means of co-operation in planning Section programs, and in arranging for joint meetings of the Sections or of the main Society and one of the Sections. No formal meetings have been held during the year, but a number of program features have been arranged through direct contact of the individual members.

Last year the Committee reported its approval of the new method of announcing notices of meetings through the weekly Journal of the Engineering Societies of New England. Another year's experience with this method of bringing the Section meetings to the attention of all members of the Society has shown its effectiveness.

It is suggested that next year's Committee give particular consideration to the presentation of papers by Section members in order to provide a greater number which would be eligible for Section prizes.

Respectfully submitted,

For the Committee,

J. B. BABCOCK, *Chairman.*

Report of the Committee on Welfare

BOSTON, March 5, 1935.

To the Boston Society of Civil Engineers:

It has been unnecessary for the Committee on Welfare to meet during the year, as all welfare work of the Boston Society of Civil Engineers, and that of other societies affiliated with the Engineering Societies of New England, has been assumed by the Emergency Planning and Research Bureau, Inc.

The Emergency Planning and Research Bureau, Inc., in addition to actually employing engineers in destitute circumstances, has an employment bureau, and during

the year 1934 there was registered with this Bureau an average of 591 engineers seeking employment and about 121 requiring financial assistance from the Bureau.

The following table shows the condition of unemployment of engineers as shown by the records of the Emergency Planning and Research Bureau during the year 1934:

1934	Total Unemployed Engineers Registered	Total Positions Secured Through Emergency Planning and Research Bureau	Total Employment at Emergency Planning and Research Bureau	Members of Boston Society of Civil Engineers Registered for Employment	Members of Boston Society of Civil Engineers Employed by Bureau
January	230	265	32	8	1
February	54	–	54	2	1
March	96	20	46	2	2
April	33	9	47	2	2
May	25	13	45	1	2
June	17	10	43	–	2
July	19	70	41	2	1
August	24	11	39	1	1
September	10	8	43	–	1
October	25	41	48	1	1
November	35	47	54	1	1
December	23	12	55	–	1
	591	506	121*	20	2*

* Individuals.

Respectfully submitted,

ARTHUR D. WESTON, *Chairman.*

Report of the Library Committee

BOSTON, March 20, 1935.

To the Boston Society of Civil Engineers:

The Library Committee has limited its activity to the matter of maintenance of the present equipment rather than to the increase in the library. Certain minor rearrangements in shelving have been made in the Library, and needed repairs have been made on bindings.

The subscriptions to periodicals have been reduced and no new books have been purchased, and yet the library is proving itself valuable.

It is regretted that certain periodicals have been taken without authority, so that it has become necessary to keep these under lock and key.

The Society is fortunate in having on file in the library a card catalogue and also

a volume of tabulations of borings in Boston, as well as accompanying maps assembled by the Committee on Subsoils of Boston, with the co-operation of the Emergency Planning and Research Bureau.

Respectfully submitted,

For the Library Committee,

ARTHUR J. HARTY, *Chairman.*

Report of the Committee on Licensing of Engineers

BOSTON, March 20, 1935.

To the Boston Society of Civil Engineers:

Following directions given to the Committee by the Board of Government, your Committee has made a study of draft legislation on this subject and has kept informed of progress in other States.

During the present year the Boston Society of Architects introduced a bill for the licensing of architects in which there were certain clauses which made it imperative for engineers to give careful consideration to the problem as to whether or not a similar bill should be introduced for licensing engineers.

While your Committee was studying this matter, the Council of the Engineering Societies of New England appointed a committee on this subject which included the three members of the Committee of the Boston Society of Civil Engineers. This comprehensive committee has developed a draft bill for licensing engineers, and has presented it under the direction of the Council. It was printed in the Journal of the Engineering Societies of New England, dated February 25, 1935. It was expected that there probably would be modifications made in this bill before it was perfected for passage by the Legislature.

While it was in the hands of the Legislative Committee, the Council of the Engineering Societies frequently met with its Committee on Licensing of Engineers, and because of the many views expressed as to the details of the bill, they came to the conclusion that it ought to have more mature study before it could be fully endorsed, and voted to direct the Committee to request that the bill be referred to the next Legislature for consideration. This will probably be done, which will give the engineers about a year for deliberation and consideration of the matter.

The Committee of the Boston Society of Civil Engineers reported the above facts to the Board of Government and has received no further directions.

Respectfully submitted,

C. B. BREED, *Chairman.*

Report of the Committee on Run-off

BOSTON, March 20, 1935.

To the Boston Society of Civil Engineers:

Herewith is a progress report of the Committee on Run-off, appointed in 1931, after the severe drought of 1930, by President Harry E. Sawtell, and reappointed each year by the then president.

The Committee has made brief reports of progress at each annual meeting, and this year will have to be content with another one of progress. Many things have conspired to prevent the completion of the work and writing of a final report; but much progress has been made towards getting into final shape the mass of data, which has been in the hands of the Committee.

The general scheme by which the report is being compiled follows:

Historical:

Appointment and personnel of Committee.
General statement.
- Unusual conditions.
- Results of subnormal rainfall.
- General comparison with former low-water periods.

Abstract of Facts — Rainfall:

Precipitation deficiencies compared to former droughts.
Progressive rainfall curve.
Table of deficiencies.

Abstract of Facts — Run-off:

Table of run-off covering period of drought.
Diagrams showing minimum yield for increasing periods of time.
Diagrams comparing yield from different drainage areas.
Table of run-off from different drainage areas comparing minimum yields for varying length of time for different droughts.

Deficiency tables for all long-time records.

Rainfall — Per Cent Yield Relation Curve:

Need for high elevation rainfall stations and snow gages.

Hydrograph for Long-time Record:

Table of mean month discharge in second feet per square mile for calendar years 1929–31.

Ground Water.

Rating of Records.

The chairman has submitted to members of the Committee, for their consideration, his first contribution on rainfall and run-off. This includes:

General Statement of Drought Conditions

		Years
Precipitation records for New England:		
Weather Bureau figures, 1888–1933		46
11 selected stations, 1834–1933		100
Comparison of foregoing for the same		46
		Inches
Driest continuous periods:		
1 year	1930	31.94
10 years	1905–1914	37.81
25 years	1907–1931	39.28
50 years	1881–1930	40.94
Individual stations, Burlington, Vermont:		
1 year	1914	22.62
5 years	1879–1883	26.30
Wettest continuous periods:		
1 year	1888	53.45
10 years	1861–1870	45.32
25 years	1850–1874	44.27
50 years	1851–1900	43.13

		Inches Collected
Precipitation and run-off, inches collected:		
Swift River at West Ware	13 years	21.29
Ware River at Gibbs Crossing	13 years	20.57
Quaboag River at West Brimfield	8 years	17.88
Run-off for New England	46 years	22.91

The Committee has been very fortunate in having the benefit of the studies being made by H. B. Kinnison, District Engineer of the United States Geological Survey, and members of his office force; and these will be available for the final report of the Committee. The Committee already has a number of preliminary diagrams showing the results of these studies and of studies of other members of the Committee.

Respectfully submitted,

ARTHUR T. SAFFORD, *Chairman.*

Report of the Committee on Subsoils of Boston

BOSTON, March 14, 1934.

To the Boston Society of Civil Engineers:

The general purpose of this Committee has been to gather data regarding the character of the subsoils of Boston and vicinity, and to present it to the Society in such form as to make it valuable for reference to any who may wish to gain a clearer idea of the geological construction of subsoils.

In previous reports there has been given the information regarding the composition of boulder clay, etc., and in the September number of the 1931 JOURNAL there was published a rather extensive progress report of the Committee's work, since which time we have had considerable help of men employed by the Emergency Planning and Research Bureau, Inc.

On the sixteen maps which the Committee has made, locating boring records and excavation records, we have noted something like 5,651 locations, but many of these boring locations really are the records of several test borings, so that we believe that the locations shown give the results of over 9,000 tests.

All of the records have been written up in final form on 4-inch by 6-inch printed file cards, and are filed in a cabinet which has now been placed in the Library of the Society.

All of the borings have been classified, typed, corrected and checked, and have been made ready for printing in a final report.

Six original sections through various parts of Boston have been revised and will show quite clearly the relations of the subsoils to one another and to the surface. The Committee believes that this report may be called final, as new data are being added very slowly, and we see no occasion for the maps being revised for some years to come.

We believe that knowledge of Boston soil conditions, as shown by the data collected and maps and sections made, will be very valuable, and that the work has been very much worth while. This data will supply the answers to anybody desiring to know where firm foundations may be obtained, and if it is necessary to locate important buildings on other than firm soils the promoters of such structures can readily obtain information as to what the supporting medium will be.

We know of no other city in the United States which has as complete information regarding its subsoil as here presented, and hope that when this report is printed, architects, engineers and real estate operators will use it to the advantage of all.

Respectfully submitted,

For the Committee,

HARRY E. SAWTELL, *Chairman.*

Report of the Executive Committee of the Sanitary Section

BOSTON, March 6, 1935.

To the Sanitary Section, Boston Society of Civil Engineers:

During the year four meetings were held, as follows:

March 7, 1934. — Regular meeting. "The Newton High-Level Sewer," by Arthur L. Shaw, of Metcalf & Eddy; *attendance*, 42.

June 16, 1934. — Inspection trip of Providence Water Purification Works at Scituate, Rhode Island, and illustrated lecture, "New Type of Filter Bottoms Using Porous Plates," by Thomas R. Camp, Associate Professor of Sanitary Engineering, Massachusetts Institute of Technology; *attendance*, 54.

October 3, 1934. — Regular meeting. "Investigation of Chemical Methods of Sewage Treatment at the Peachtree Demonstration Plant at Atlanta, Georgia," by Elson T. Killam, Chief Engineer with Alexander Potter, New York City; *attendance*, 43.

December 5, 1934. — Regular meeting. "Some Biological Phases of Air Sanitation," by Mr. W. F. Wells of the Harvard School of Public Health; *attendance*, 37.

Attendance. — Attendance at meetings has varied from 37 to 54, with an average of 44.

Membership. — The present membership of the Section is 194. During the past year no members were added to the roll, 5 were lost by resignation, and 4 by death.

Executive Committee Meetings. — Six meetings of the Executive Committee were held during the past year.

Respectfully submitted,

For the Executive Committee,

PAUL F. HOWARD, *Clerk.*

Report of the Executive Committee of the Designers Section

BOSTON, March 13, 1935.

To the Designers Section, Boston Society of Civil Engineers:

During the past year eight regular meetings of the Section have been held, as follows:

March 14, 1934. — Annual meeting, election of officers. "Stresses in Unsymmetrical Masonry and Composite Members, Subjected to Direct Stress and Oblique Bending," by Albert B. Rich; *attendance*, 27.

April 11, 1934. — "Construction Features of the New Christian Science Publishing House," by A. B. MacMillan of the Aberthaw Construction Company; *attendance*, 19.

May 9, 1934. — "On the Application of the Theory of Elasticity and the Theory of Plasticity to Foundation Problems," by Dr. Leo Jürgenson, Research Associate in Soil Mechanics, Massachusetts Institute of Technology; *attendance*, 21.

October 10, 1934. — "A Discussion of Certain Chemical and Physical Characteristics of Cement and Their Relation to the Qualities of Concretes," by W. J. D. Reed-Lewis, Engineer with the Lawrence Portland Cement Company; *attendance*, 63.

November 14, 1934. — "A Summer's Journey in Search of Design," by Prof. Edwin H. Wright of the Department of Fine Arts of Tufts College; *attendance*, 28.

December 12, 1934. — "Moving the Drawbridge at Fore River and the Construction of the Foundations for the Cape Cod Canal Bridges," by Walter G. Cheever, General Manager of the Blakeslee Rollins Corporation; *attendance*, 48.

January 9, 1935. — "Sewage Treatment and Some Structural Problems of Large Disposal Plants," by Frank A. Marston and Arthur L. Shaw, members of Metcalf & Eddy, Engineers; *attendance*, 85.

February 13, 1935. — "The New Cambridge–Concord Highway," by F. D. Sabin, and "Improvements on the Newburyport Turnpike at Newburyport," by J. E. Lawrence. Both speakers are district highway engineers of the Massachusetts Department of Public Works. This was a joint meeting with the Highway Section of the Society; *attendance*, 90.

The total attendance at these meetings was 381, or an average of 48 per meeting.

Membership in the Section in March, 1934, was 177. During the year 2 members have died and 6 have resigned. The membership at present is 169.

Respectfully submitted,

For the Executive Committee,

ALBERT HAERTLEIN, *Clerk.*

Report of Executive Committee of the Highway Section

BOSTON, February 13, 1935.

To the Highway Section, Boston Society of Civil Engineers:

During the past year four meetings have been held.

February 28, 1934. — Annual meeting, election of officers. "Research in Frost Action in Soils and its Effects on Highways," by Dr. Arthur Casagrande of Harvard University; *attendance*, 25.

May 23, 1934. — "Recent Developments in the Design and Construction of Concrete Pavements," by L. E. Andrews of the Portland Cement Association; *attendance*, 20.

September 26, 1934. — Joint meeting with Boston Society of Civil Engineers. "The Use of Reinforced Concrete Rigid Frame Bridges in Grade Crossing Elimination," by R. R. Zipprodt of the Portland Cement Association; *attendance*, 47.

November 28, 1934. — "Recent Developments in Bituminous Pavements," by A. A. Johndrow of the Warren Brothers Roads Company; *attendance*, 35.

The average attendance during the year was 32.

During the year 1 member was added, 6 members resigned, and 1 member was lost through death. The present membership is 96.

Respectfully submitted,

For the Executive Committee,

ALEXANDER J. BONE, *Clerk.*

May 24, 1934. — "Municipal Refuse Disposal," by Mr. Harrison P. Eddy, Jr., of Metcalf & Eddy; *attendance*, 21.

September 27, 1934. — Field trip to the new bridge across the Cape Cod Canal at Bourne, Massachusetts; *attendance*, 51.

October 4, 1934. — "Personal Organization and Life in the United States Coast and Geodetic Survey," by Capt. F. H. Peacock, United States Coast and Geodetic Survey; *attendance*, 23.

November 1, 1934. — Field trip to the new bridge across the Cape Cod Canal at Sagamore, Massachusetts; *attendance*, 81.

November 8, 1934. — "Foundations and Foundation Problems," by Mr. J. Stuart Crandall, Crandall Engineering Company; *attendance*, 26.

December 6, 1934. — "The Present Status of the Activated Sludge Process of Sewage Treatment," by Mr. Frank L. Flood, Metcalf & Eddy; *attendance*, 19.

December 13, 1934. — Field trip to the Woonsocket, Rhode Island, sewage disposal plant; *attendance*, 21.

January 7, 1935. — "The Romance of the Tropics," by Mr. Robert Stark of the United Fruit Company; *attendance*, 18.

February 19, 1935. — "Municipal Planning," by Mr. Edward T. Hartman, State Consultant on Planning in Massachusetts; *attendance*, 17.

The average attendance at meetings was 22.4.

The average attendance on trips was 51.

There are at present 46 members in school out of a total membership of 214.

Respectfully submitted,

For the Executive Committee,

KENNETH F. KNOWLTON, *Clerk*.