HOLBROOK - CABOT & ROLLINS CORPORATION

HEAVY CONSTRUCTION

HEAVY CONSTRUCTION

HEAVY CONSTRUCTION

HOLBROOK·CABOT & ROLLINS CORPORATION

6 BEACON STREET, BOSTON, MASSACHUSETTS

52 VANDERBILT AVENUE, NEW YORK, N. Y.

HEAVY CONSTRUCTION

TO the engineer "Heavy Construction" is as definitely a descriptive term as is "Mill Construction," or "Reinforced Concrete." To the non-professional man, "Heavy Construction" suggests certain inherent characteristics of construction rather than any specific type of work. As interpreted and applied to modern industrial undertakings by the Holbrook, Cabot & Rollins Corporation, "Heavy Construction" embraces all that the engineer includes in the term and all that the non-technical man seeks to describe by the phrase. Beyond all that, it includes the successful accomplishment of a peculiar class of construction that is none the less hazardous because it is planned, directed and executed by skilled engineers, and none the less constructive because so large a portion of it is necessarily lost to view in the finished structure.

To the casual eye, which sees only that portion of the work above ground, the work of the Holbrook, Cabot & Rollins Corporation is often either altogether buried under tons of rock and earth or submerged beneath fathoms of water, or is given a false and belittled value by the superstructure erected on it. For that reason we have, in the succeeding pages of this book, adopted a rather unusual pictorial treatment of some of the work of the organization, in the hope that the reader will gain a truer conception of its scope than would otherwise be possible, and will realize its relation to the commoner and more ordinary types of construction. To accomplish this, scale drawings have been made on tracing paper of some of the Corporation's work in and around Boston Harbor, and these drawings of the underground or underwater work have been superimposed on half-tones of the scenes as they appear today. Such of the work of Holbrook, Cabot & Rollins Corporation as is under water or earth and, therefore, cannot be seen in a photograph of the finished job, is shown in black

HEAVY CONSTRUCTION

IN

BOSTON HARBOR DISTRICT

BY

HOLBROOK, CABOT & ROLLINS CORPORATION

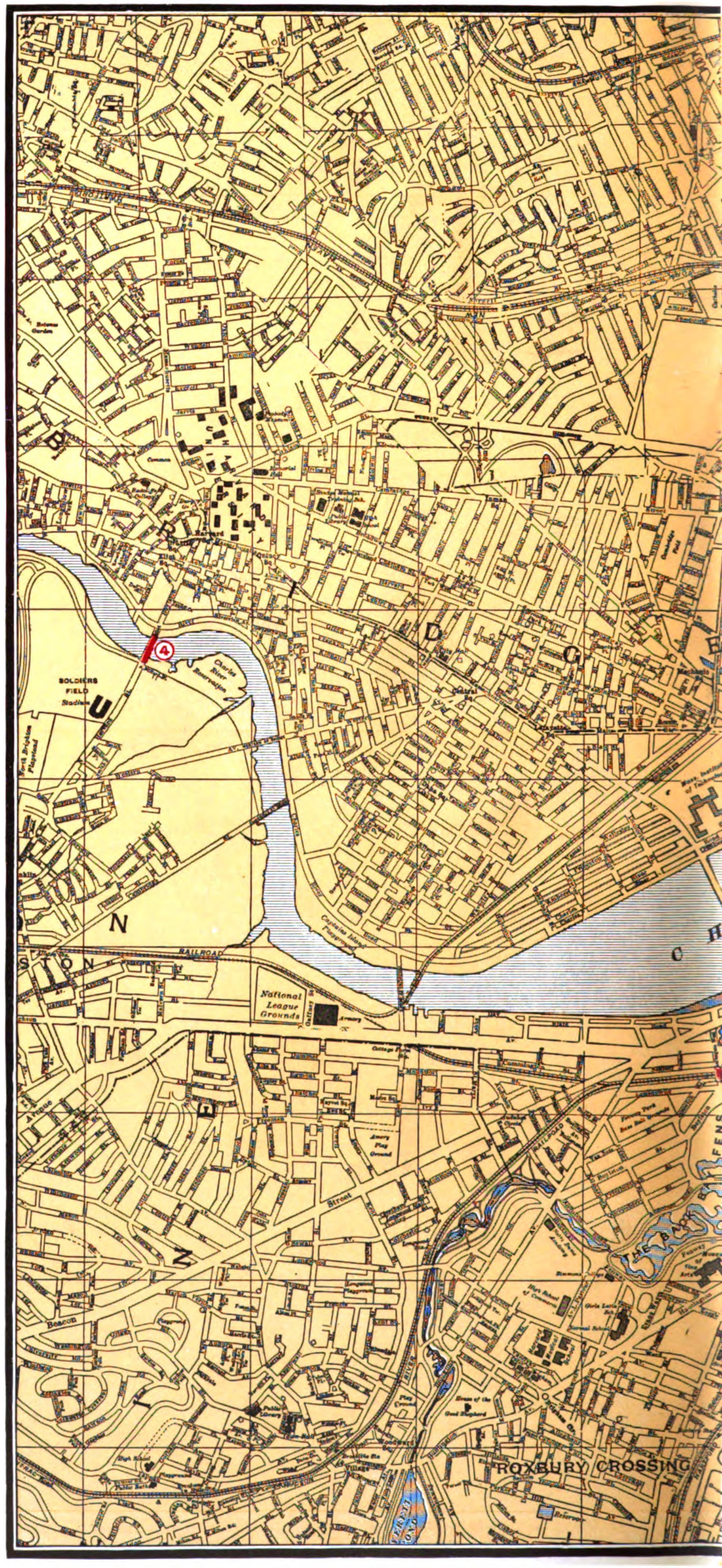
6 Beacon Street, Boston

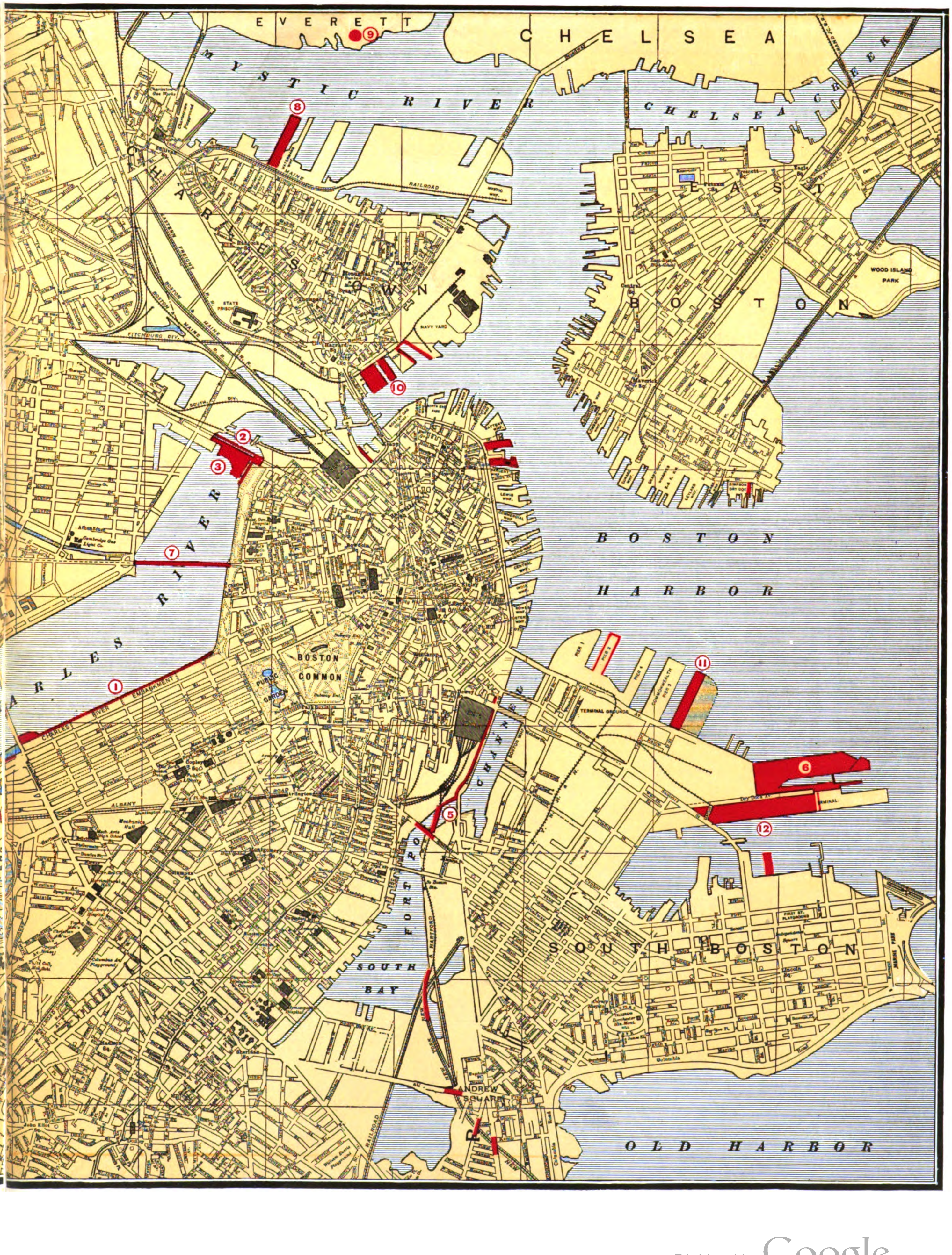
52 Vanderbilt Avenue, New York

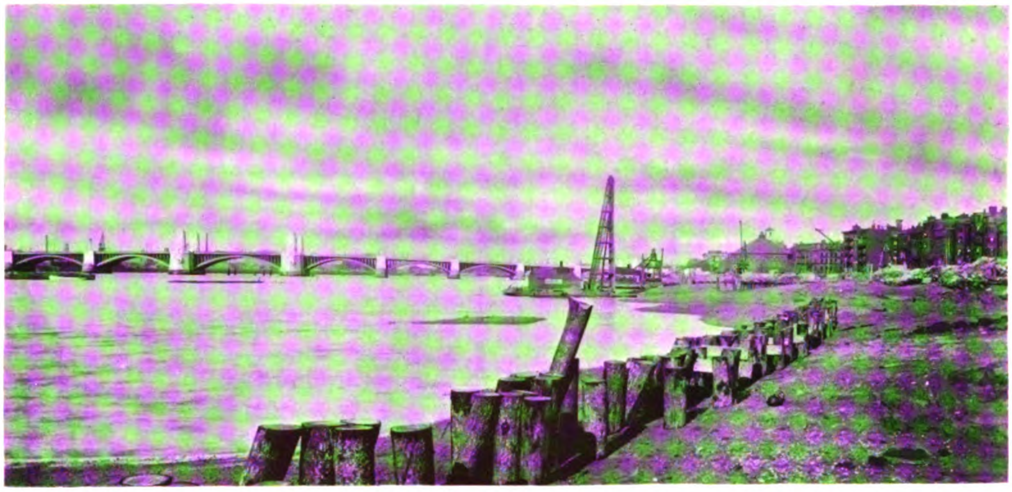
All Red Areas Represent Work of This Organization

Among those illustrated and described in this book are:

1. Charles River Embankment
2. Charles River Bridge
3. Charles River Dam
4. Anderson Bridge
5. Fort Point Drawbridge
6. Boston Dry Dock
7. Cambridge Bridge
8. Revere Sugar Refinery Pier
9. Boston Consolidated Gas Company, Gasometer
10. Hoosac Tunnel Docks
11. Boston Fish Pier
12. Boston Army Supply Base



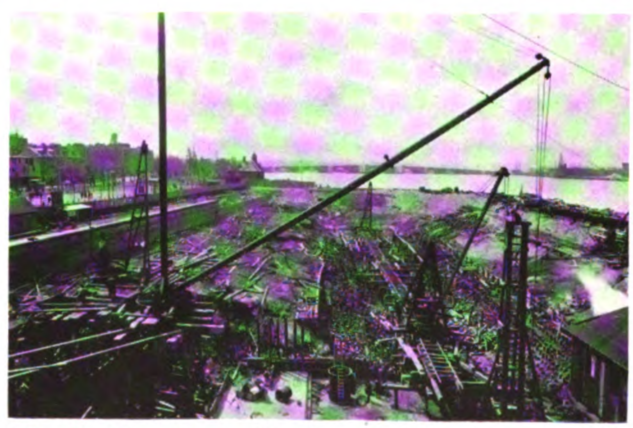

EVERETT
CHELSEA
MYSTIC RIVER
CHELSEA CREEK
CHARLESTOWN
EAST BOSTON
WOOD ISLAND PARK
STATE PRISON
NAVY YARD
FITCHBURG DIV.
RAILROAD
BOSTON HARBOR
BOSTON COMMON
PUBLIC GARDEN
CHARLES RIVER
CHARLES RIVER EMBANKMENT
FORT POINT CHANNEL
TERMINAL GROUNDS
ALBANY
SOUTH BAY
SOUTH BOSTON
ANDREW SQUARE
OLD HARBOR
1
2
3
5
6
7
8
9
10
11
12



Charles River Embankment—Construction Scene

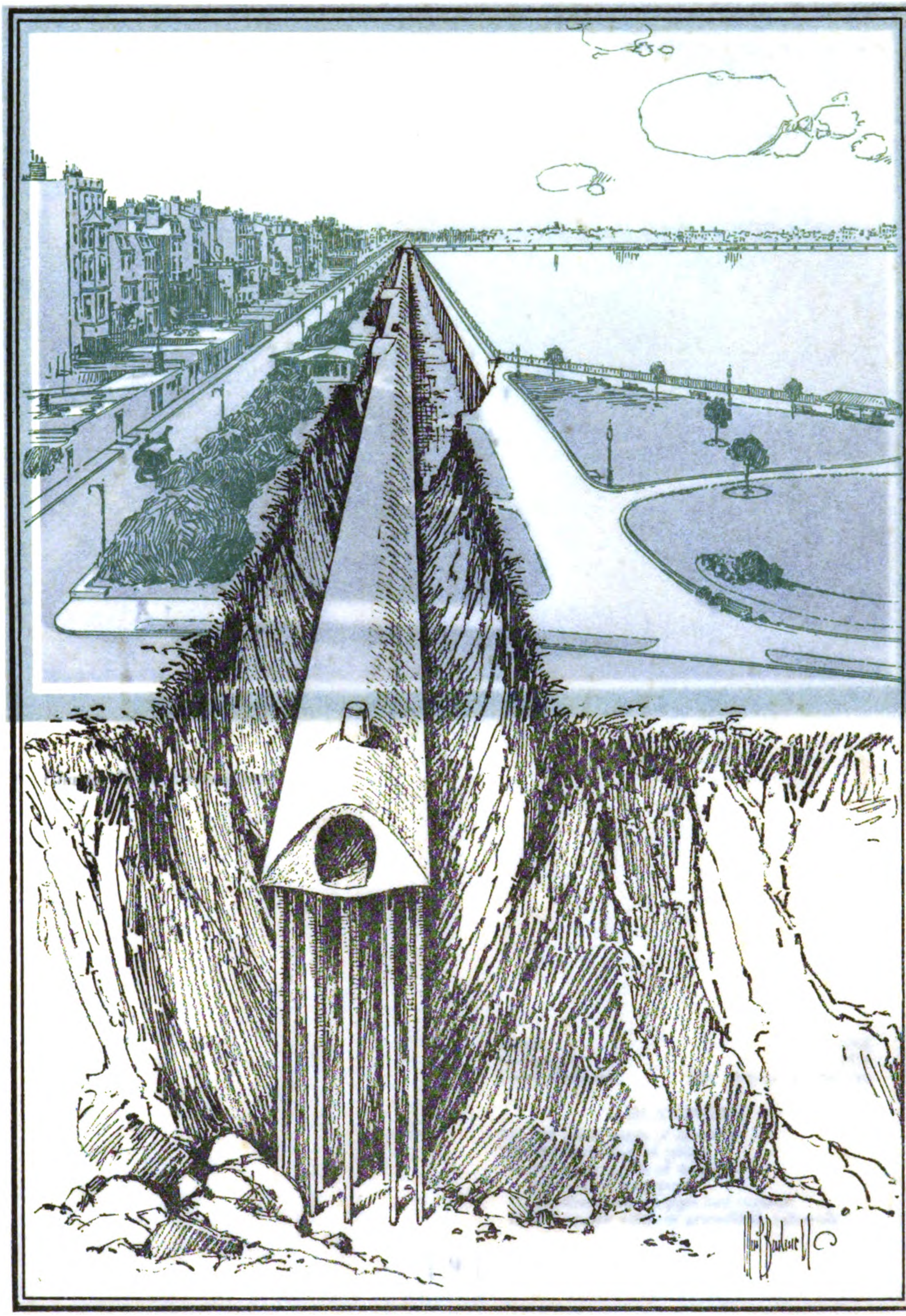
on the tracing, and, taken in conjunction with the tinted portion of the drawing (or with the half-tone underneath), the true relation and proportion of their work to the whole may be seen, and a proper conception of its bulk and the difficulties which attended its execution be readily obtained.

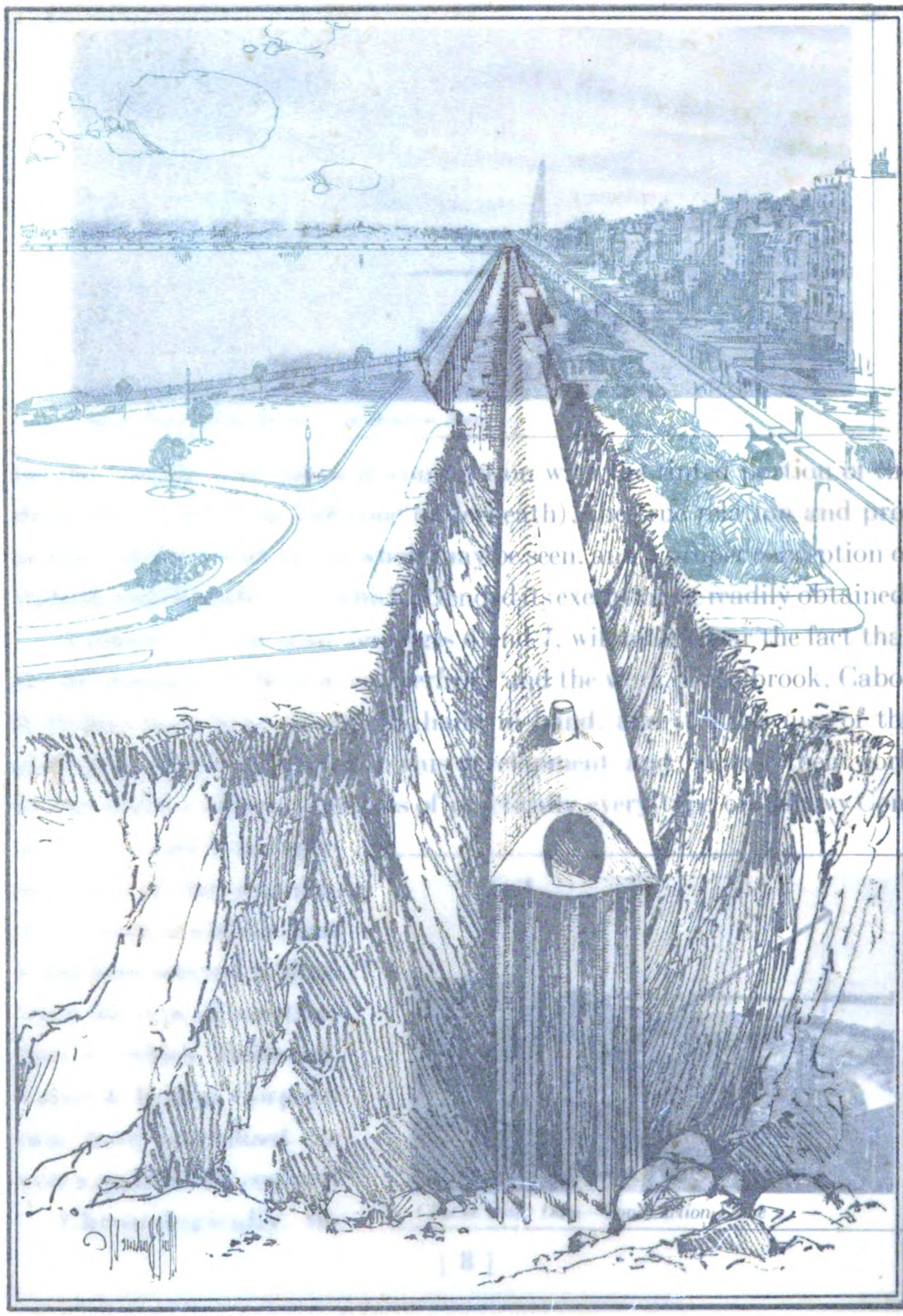
A reference to the map, on pages 6 and 7, will make clear the fact that the development of Boston's waterfront and the work of Holbrook, Cabot & Rollins have gone practically hand in hand, and it is because of the great part they have played in this development, and because their work in this district affords examples of practically every type of "Heavy Construction" and is so representative of the organization's work as a whole, that it has been selected to illustrate the type of construction in which Holbrook, Cabot & Rollins Corporation have specialized for over a quarter of a century.



Charles River Dam—Construction Scene

Chronologically, the



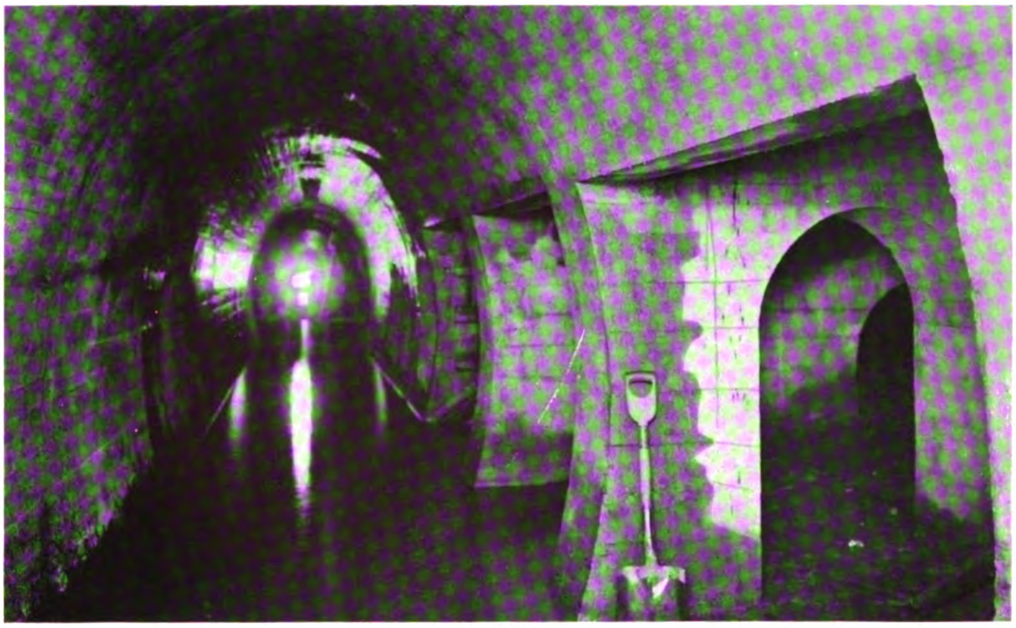


Charles River Embankment

Begun 1908
Completed 1910
Chief Engineer .... MR. HIRAM A. MILLER

QUANTITIES

337,700 cubic yards of earth fill
260,000 linear feet of piling
12,100 cubic yards of masonry
120 tons of iron work
11,000 linear feet of pipe and conduit
10,000 square yards of granolithic sidewalk

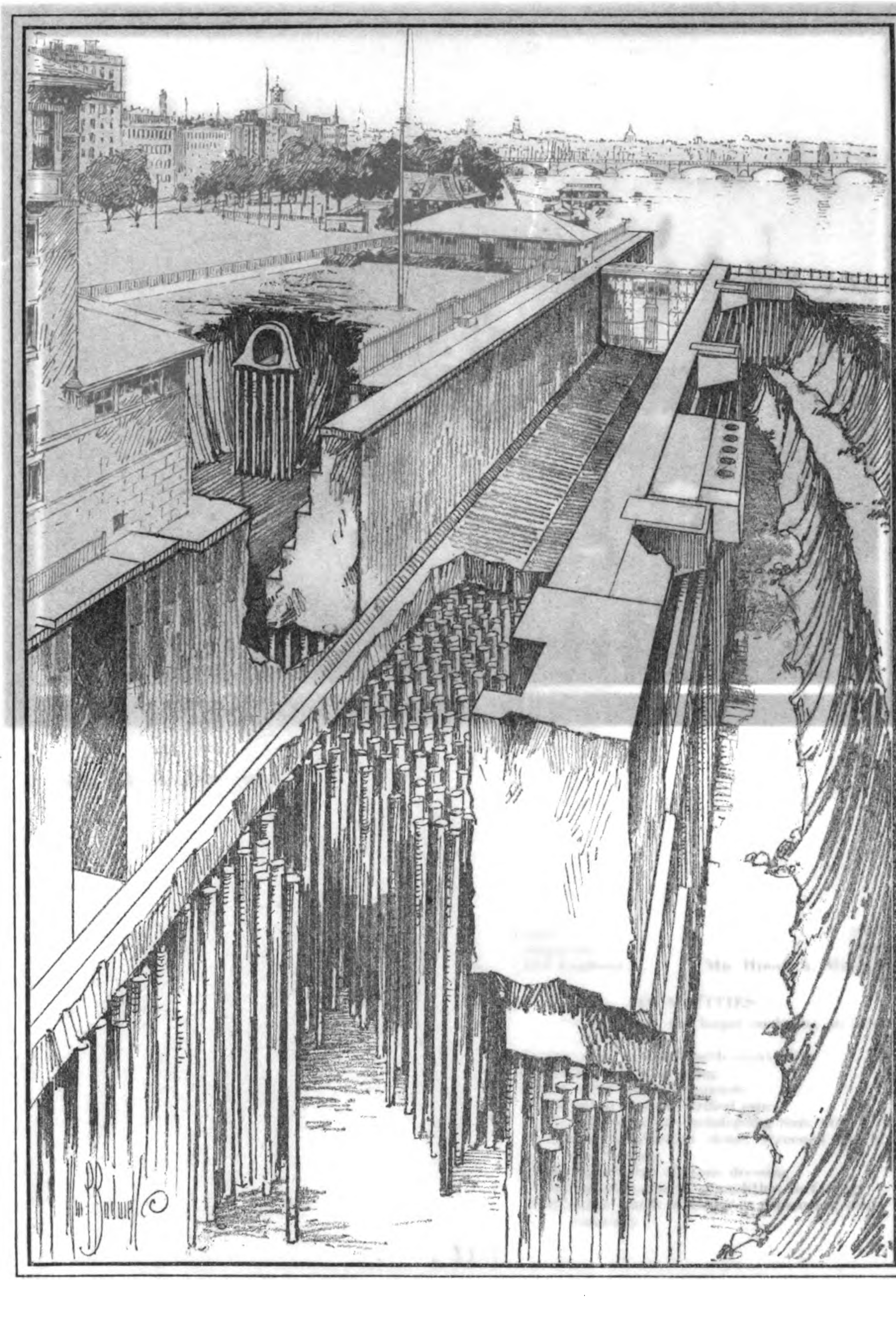


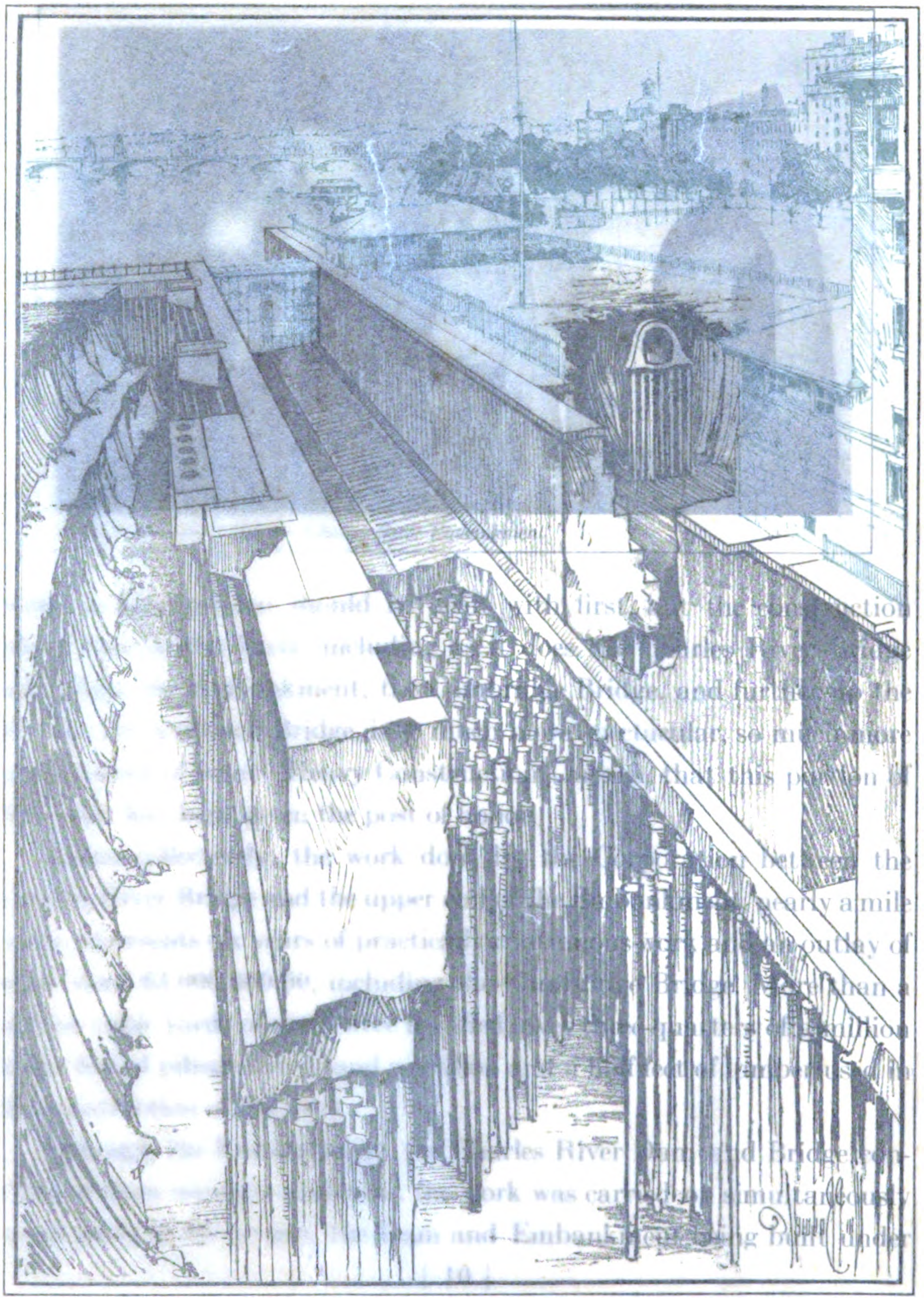
Overflow Chamber—Sewer—Charles River Embankment

work in Charlestown should be dealt with first, but the construction along the Charles River, including as it does the Charles River Bridge and Dam, the Embankment, the Cambridge Bridge, and further up the stream, the Anderson Bridge, is so much more spectacular, so much more an exponent of what "Heavy Construction" means, that this portion of the work has been given the post of honor.

Taken collectively, the work done by the Corporation between the Charles River Bridge and the upper end of the Embankment, nearly a mile away, represents six years of practically continuous work and an outlay of more than $3,000,000.00, including the Cambridge Bridge. More than a million cubic yards of earth were handled, over three-quarters of a million linear feet of piling driven, and a million and a half feet of lumber used in the construction of the work.

Although the Embankment, the Charles River Dam and Bridge constituted three separate contracts, the work was carried on simultaneously on all parts of the project, the Dam and Embankment being built under





Lock—Charles River Dam

Begun 1907
Completed 1909
Chief Engineer.........MR. HIRAM A. MILLER

QUANTITIES

2	cofferdams, the larger enclosing an area of $3\frac{1}{2}$ acres
730,000	cubic yards of earth excavation
168,500	linear feet of piling
10,000	cubic yards of concrete
5,000	linear feet of vitrified pipe
531	tons of metal—reinforcing rods, etc.
9,700	tons of broken stone, screened gravel and rip-rap
20,000	square feet of stone dressing
1,800	square yards of granolithic surfacing
2,825	cubic yards of ashlar or dimension stone masonry

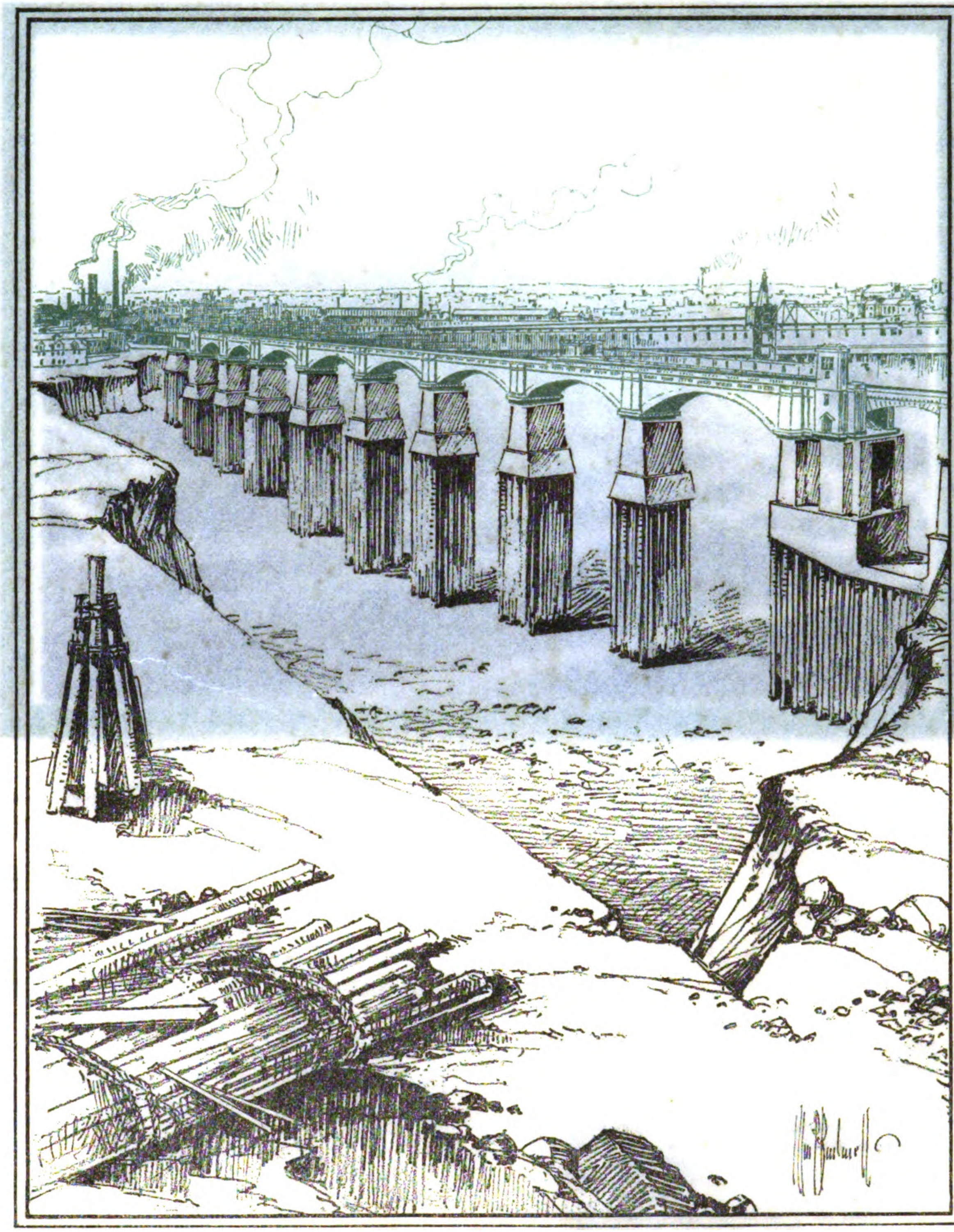
the supervision of Mr. Hiram A. Miller as Chief Engineer for the Charles River Basin Commission, and the Charles River Bridge under Mr. George A. Kimball, Chief Engineer of Elevated and Subway Construction for the Boston Elevated Railway Company.

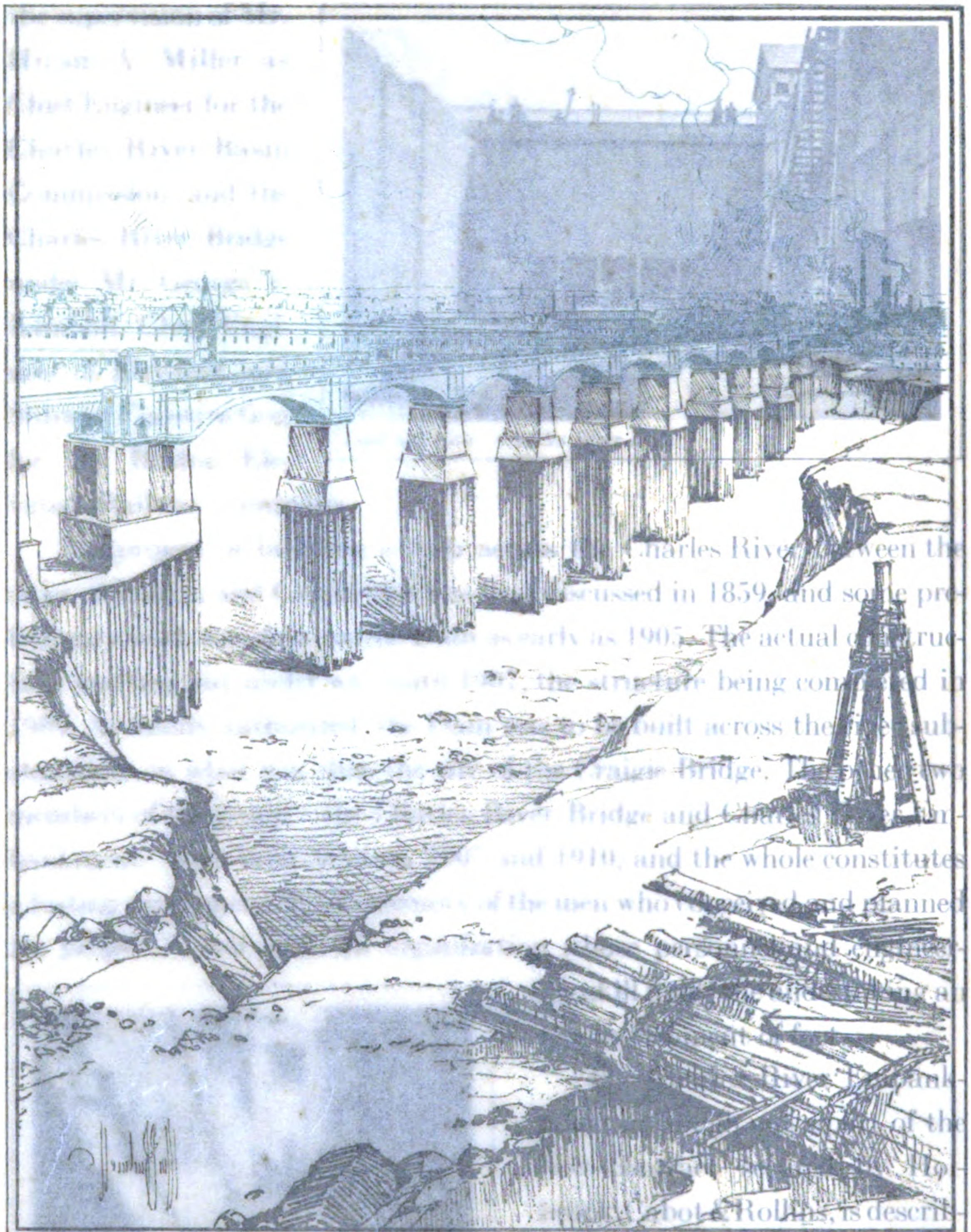
Lock and Gate—Charles River Dam

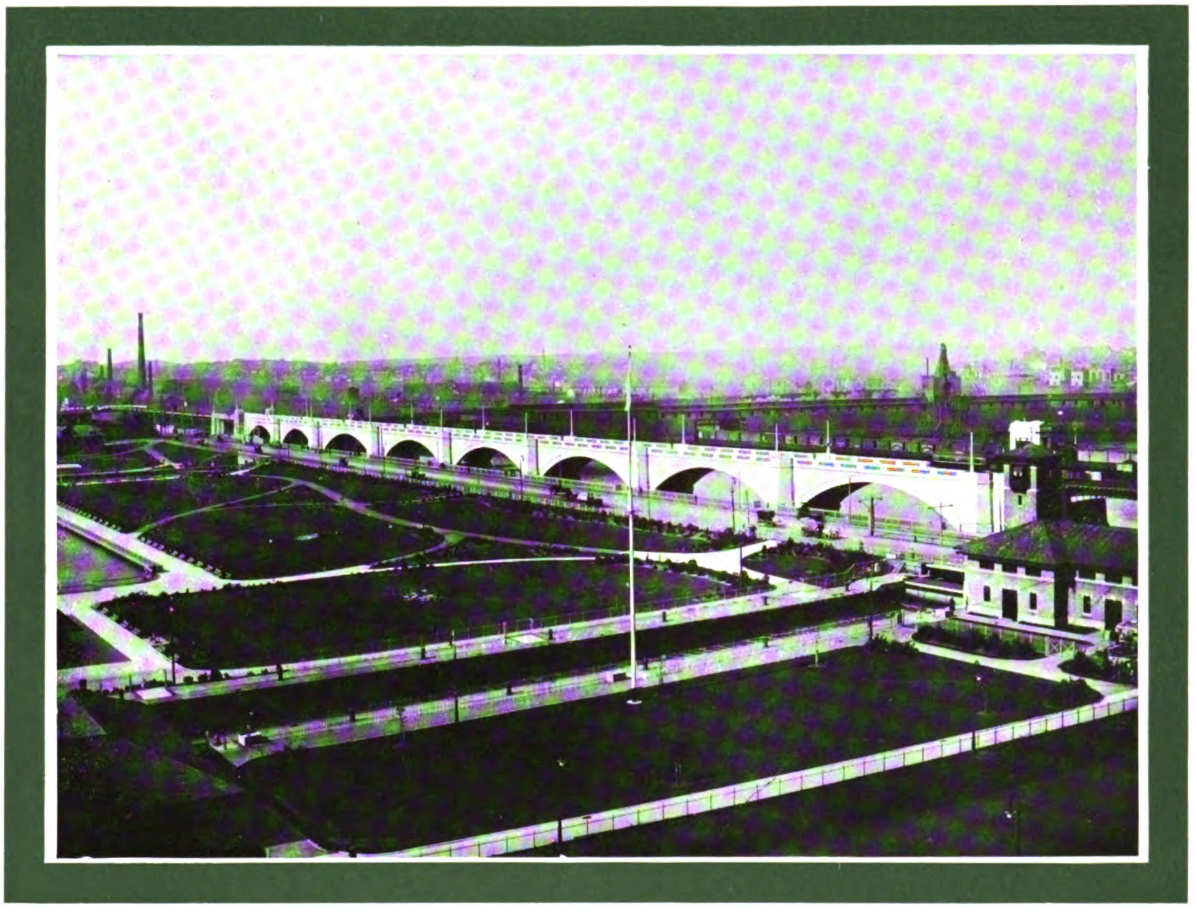
The project of building a dam across the Charles River between the cities of Boston and Cambridge was first discussed in 1859, and some preliminary work was done on the Dam as early as 1905. The actual construction was not put under way until 1907, the structure being completed in 1909. As finally authorized, the Dam was to be built across the river substantially on what was then the site of the Craigie Bridge. The other two members of the group—the Charles River Bridge and Charles River Embankment—were built between 1907 and 1910, and the whole constitutes a lasting monument to the memory of the men who conceived and planned the project as well as to the organization whose personnel and engineering skill made the undertaking an accomplishment of fact.

Gate Recess—Charles River Dam

The Charles River Embankment, although not a part of the first contract secured by Holbrook, Cabot & Rollins, is described first for the reason that it is in a sense independent of the other





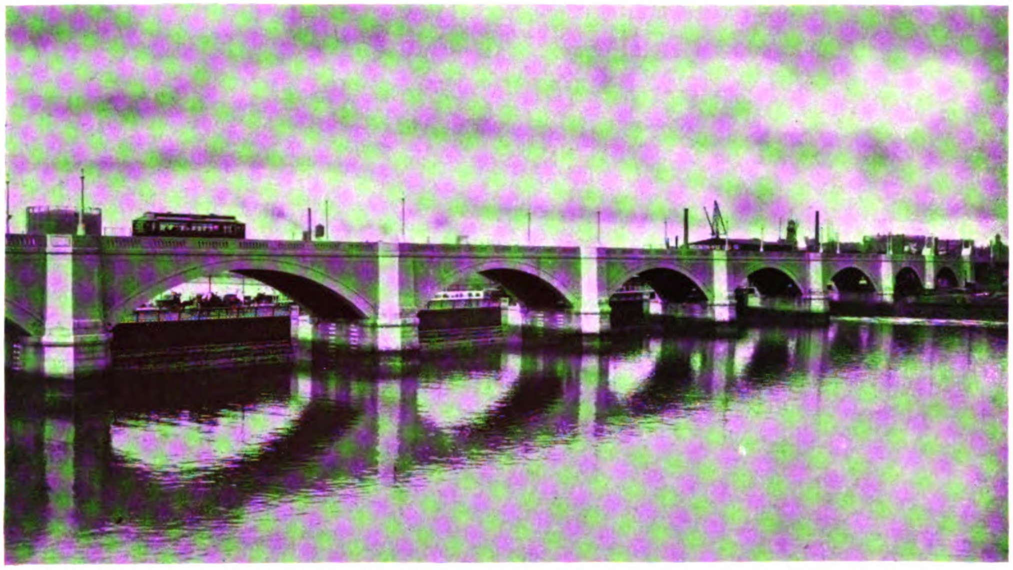


Charles River Bridge

Completed 1912
Chief Engineer....... Mr. George A. Kimball

QUANTITIES

5,970 piles in the bridge foundations
24,633 cubic yards of concrete in the bridge foundations
9,000 cubic yards of concrete in the superstructure
3,846 cubic yards of granite in the piers
395 tons of reinforcing rods
560,000 feet B. M. of sheeting in cofferdams
200 tons of cast steel in hinges
200 tons of I beams for track stringers



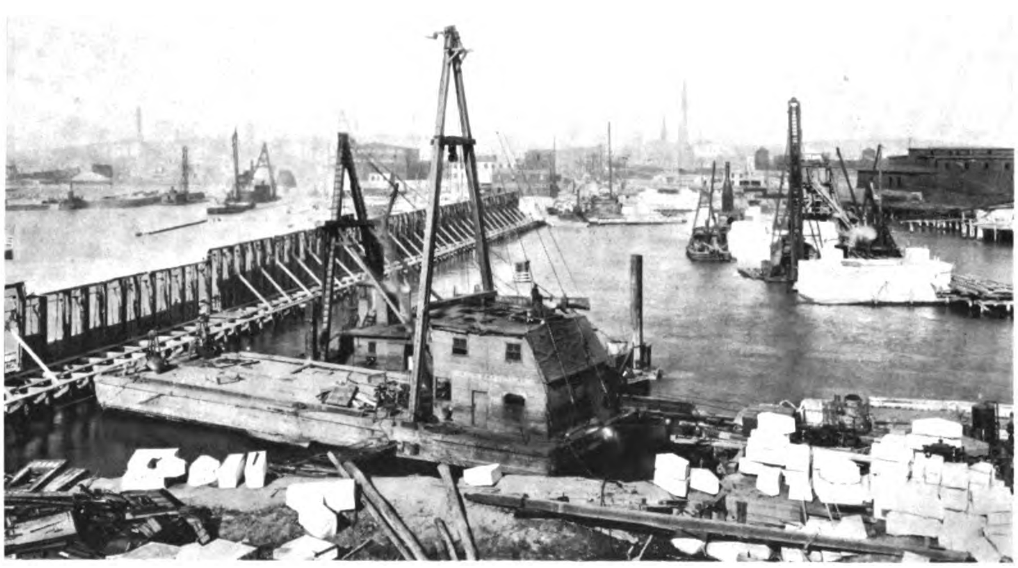
Charles River Bridge—Looking Upstream

development work done in the Charles River Basin, the different parts of which are so closely inter-related that in the description of any one of them cross-references must be made to the others and because it affords a convenient point from which to view the whole undertaking. The Embankment, in which is built the Boston Marginal Conduit, featured on page 9, reclaimed the Boston shore of the river, making a parkway out of what many Bostonians will remember as an unsightly tide flat prior to the construction of the Charles River Basin and the elimination of tidal ebb and flow. The cost of the Embankment was $538,000.00, the work commencing in 1908 and being completed in 1910. A study of the construction photographs on pages 8 and 10, and the phantom view on page 9, will not only make plain the character of this particular portion of the work in the Basin, but will also convey an idea of what the term "Heavy Construction" may be made to cover.

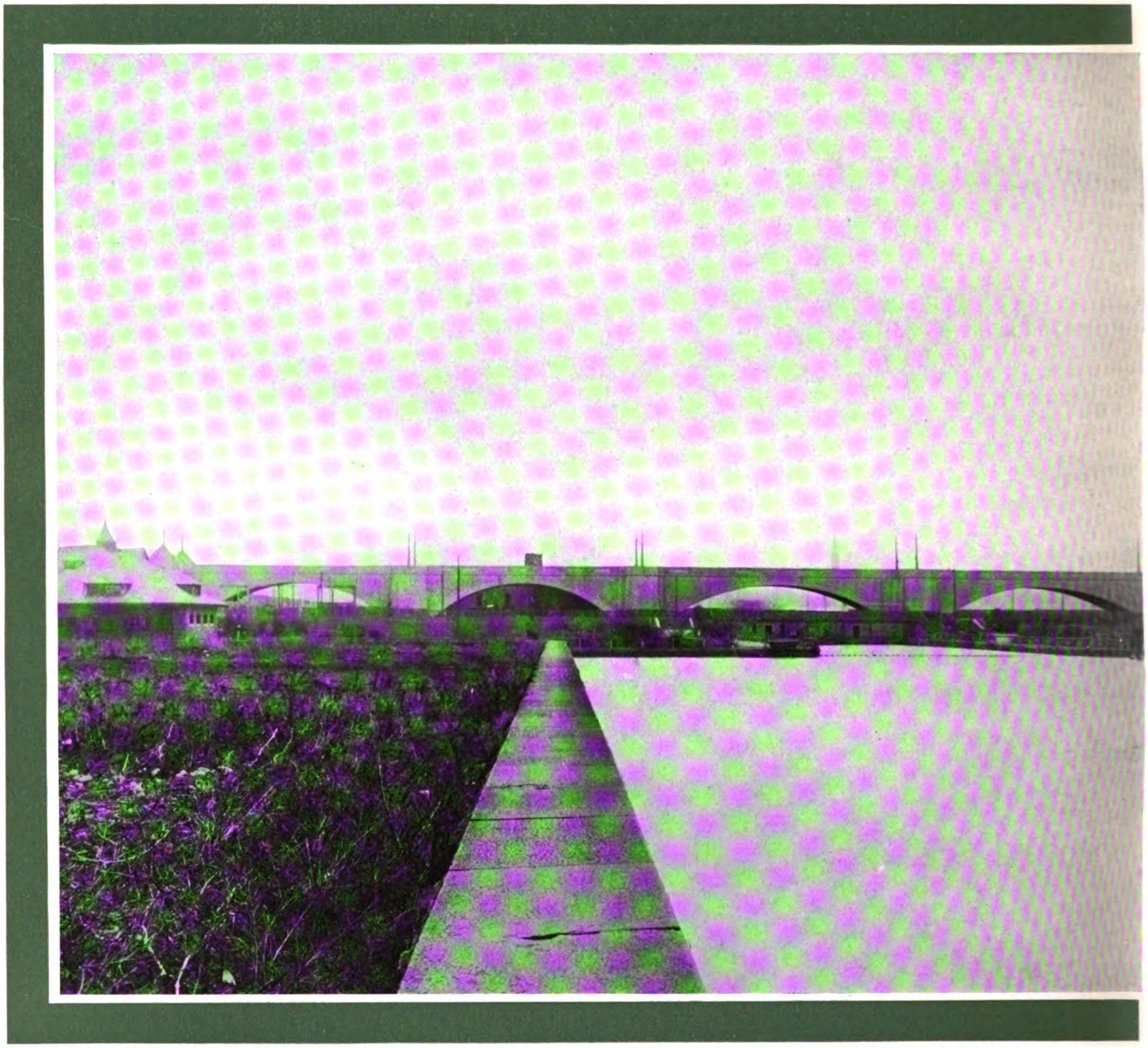
The Charles River Bridge, shown pictorially on page 13, is located on the downstream side of the Charles River Dam. Construction began on the Bridge proper in 1907, the entire cost being $3,500,000.00, and the work was finished in 1912. The structure, which belongs to the Boston Elevated Railway Company, has a total length of 1.18 miles, running from North Station, Boston, where it connects with the subway and elevated systems, to Lechmere Square, East Cambridge. It is double-tracked to carry surface cars and crosses the Charles River on an ornamental concrete viaduct about 1,700 feet long, near the Boston end of which is located the Strauss Trunnion Bascule Drawbridge mentioned in connection with the Lock in the Charles River Dam.

The Bridge consists of ten arched spans, seven of which are over the river and the remainder over land, a draw span over the Lock and a steel girder span, faced with concrete, over Prison Point Street.

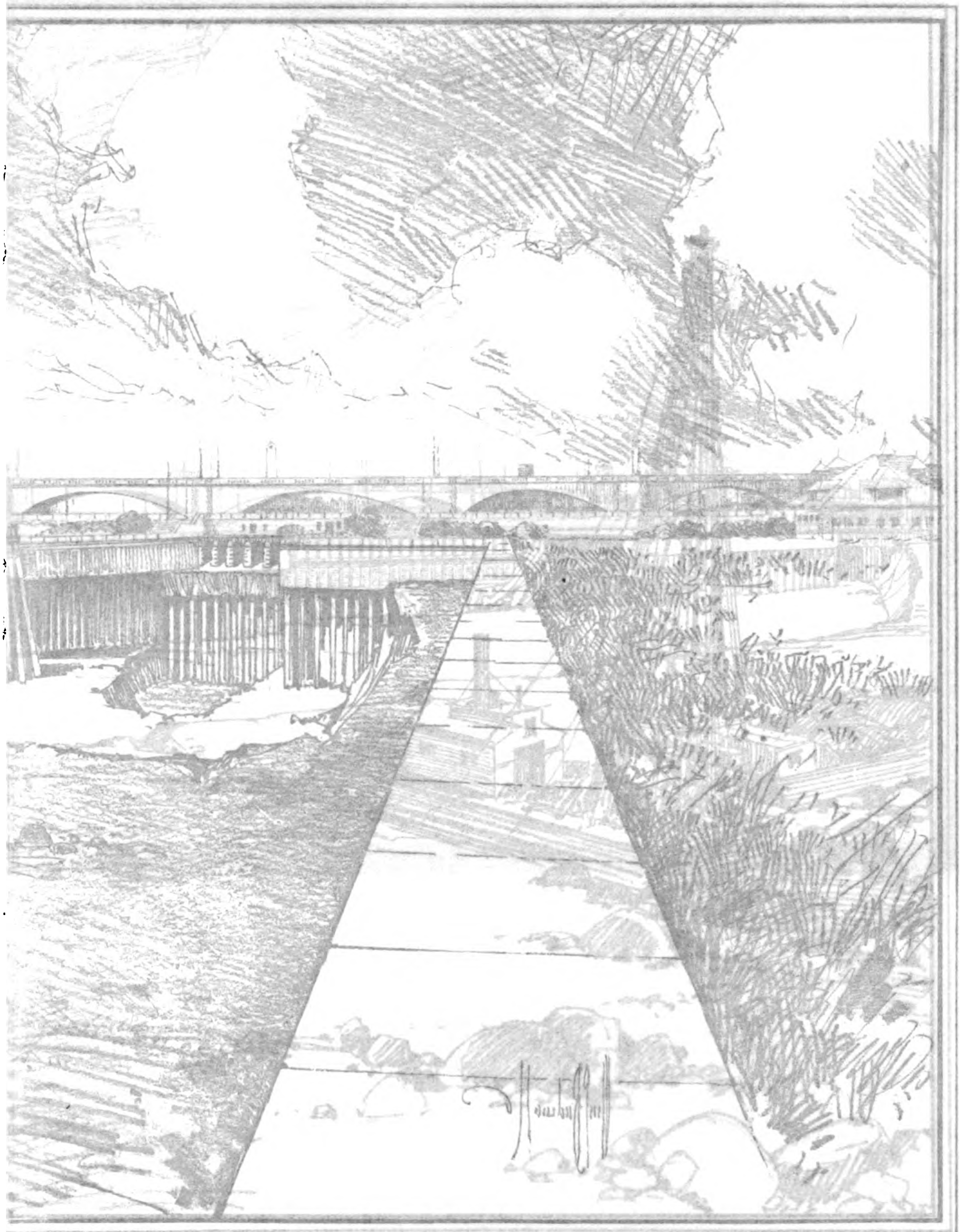
The profile of the river bottom at the site of the Bridge, as it was before construction began, showed a depth of water at low tide varying from nothing at the shores to about 25 feet in the middle of the river. The bottom was silt and mud to a depth of from one foot in the center of the river

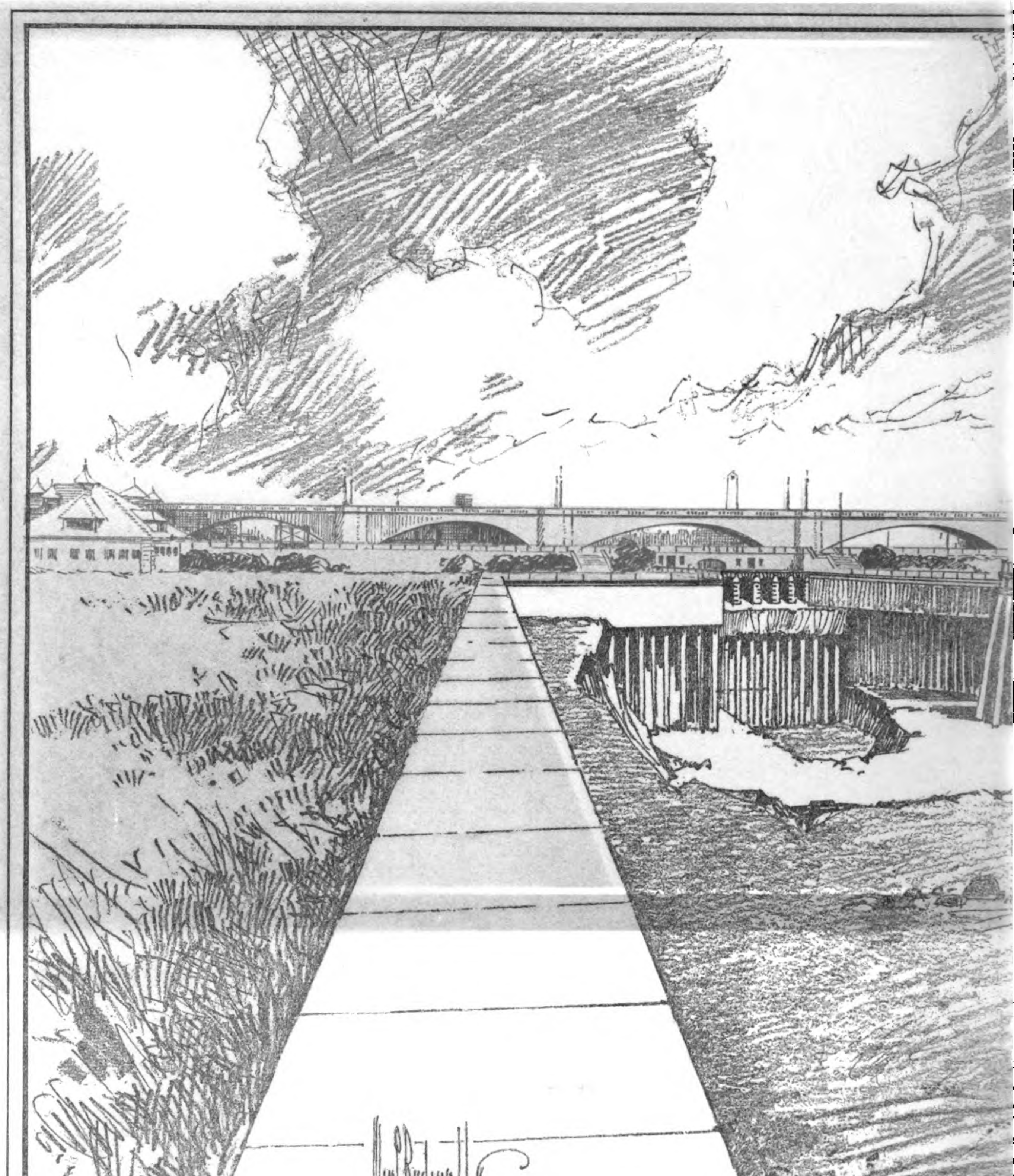


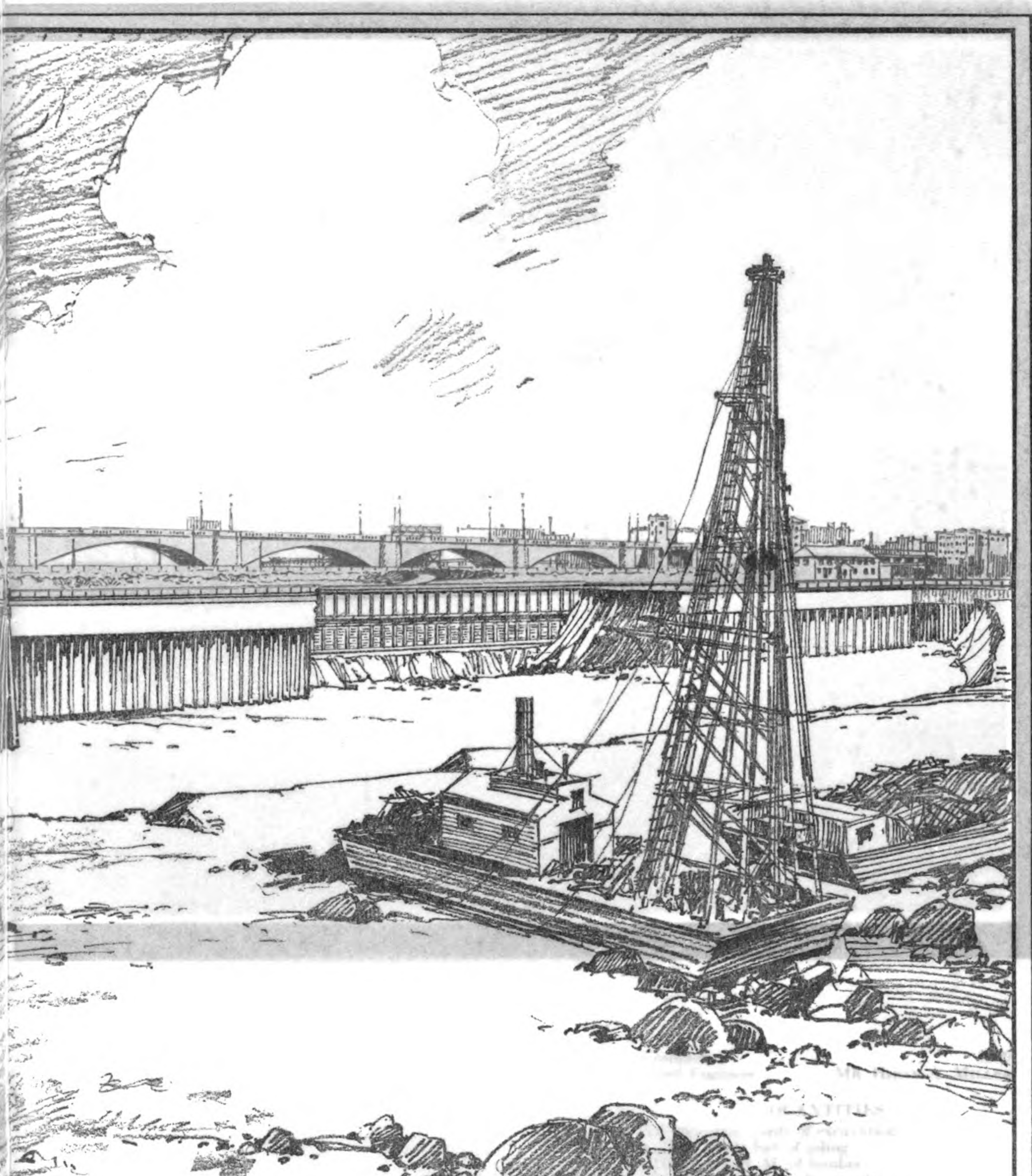
Cut-off Dam—Charles River Dam

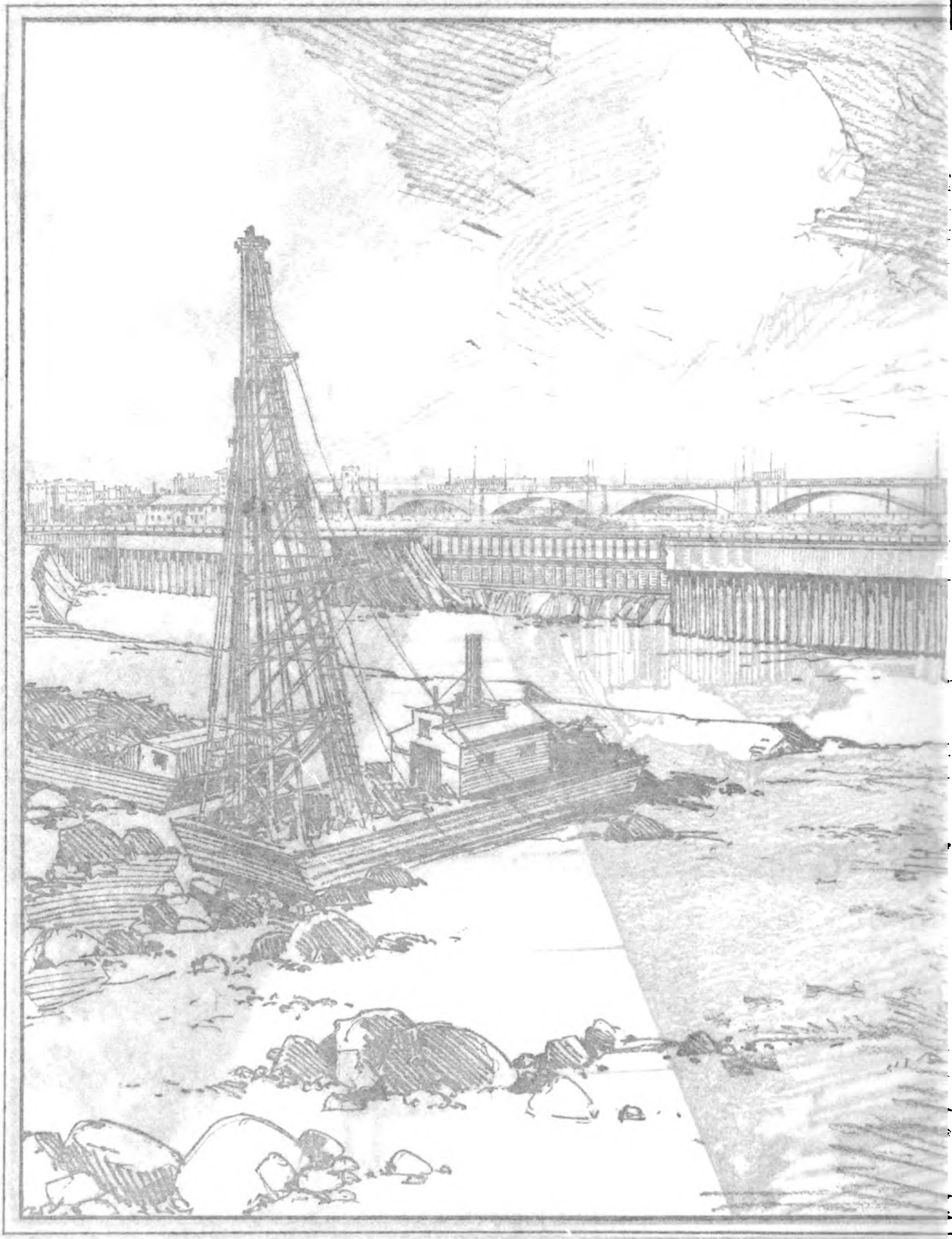


Charles River Dam









Completed 1909
Chief Engineer......... MR. HIRAM A. MILLER

QUANTITIES

833,000 cubic yards of excavation
512,000 linear feet of piling
714,000 feet B. M. of lumber
43,000 cubic yards of concrete
2,200 cubic yards of ashlar masonry
22,800 tons of rip-rap
870 tons of iron and steel

Charles River Dam—Under Construction

to 20 feet at the shores, and underneath the mud was a stratum of sand and gravel from 2 to 6 feet deep, which in turn was underlaid by stiff blue clay to a depth of about 65 feet below low water at the deepest point.

At this point it is necessary to call attention to the fact that the plans for the Charles River Dam called for filling to be placed over the mud bottom, raising the bottom of the river on the north side of the Dam and the south side of the Bridge to about three feet below low water, and sloping downward to the north on a slope of about 2 to 1. It was, therefore, necessary to carry the foundations of the Bridge through this fill to the natural soil and to remove the mud from the locations of the piers. To avoid needless expense, plans were made to build the foundations for the Bridge before the filling for the Dam was begun. This necessitated carrying on construction while the river was being used for navigation and still subject to tidal current.

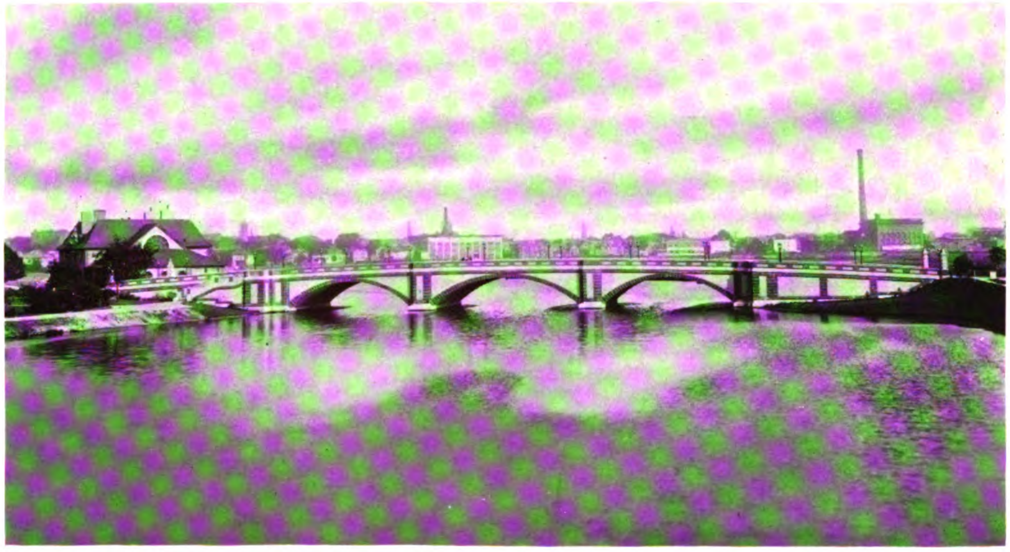
The first operation was to dredge the mud and silt to the depth required for the bottom of the piers, which varied from about 18 feet to about 33 feet below low water. Piles were driven over the area of the foundations, which were then enclosed by a wall of 6-inch hard pine sheathing, driven firmly into the bottom, and of sufficient length to extend above high tide.

An examination of the bottom after the sheeting was driven showed that the silt had come back in some of the piers which were most exposed to the current, and had completely covered the tops of the piles. The removal of this silt was attended by difficulties, but was finally accomplished by means of a centrifugal sand pump, the suction of which was guided by a diver, who also used a water jet to stir up the mud in the vicinity of the suction, the power of the latter being so great that on one occasion a paving stone was drawn up and thrown through the casing of the pump.

After the bottoms were cleaned out, concrete was deposited by means of a bottom opening bucket and the piers filled to about 3 feet below low water. The water was then pumped out and the upper layer of concrete and the balance of the masonry laid in the dry.

From a level 2 feet below low water up to the level of the top of the Dam, where the arches spring, the piers of the bridge were built hollow in order to save weight on the footings. They consist of concrete walls which are heavy under the main arch ribs, but comparatively light in the cross walls, and faced with granite. At the level of the skew backs the piers were floored over with a reinforced concrete slab. The arch seats are rectangular and made in the granite, the space between the two abutting arches on each pier having the interior portion of concrete doweled to the concrete below with heavy vertical reinforcing rods.

The arches have clear spans of from 98 feet and 4 inches to 125 feet and 4 inches. Each consists of two main ribs supporting arched reinforced concrete cross floor beams which, in turn, carry the track stringers. The ribs are 4 feet wide and vary in depth from 6 feet at the spring to 4 feet, 4½ inches at the crown. The rise in each case is 19 feet and 4 inches. The arrangement of the ribs is such that a clear passage is left under the floor and through the piers from end to end of the Bridge, affording space for another double track location if needed. Granolithic sidewalks run on either side of the



Anderson Bridge

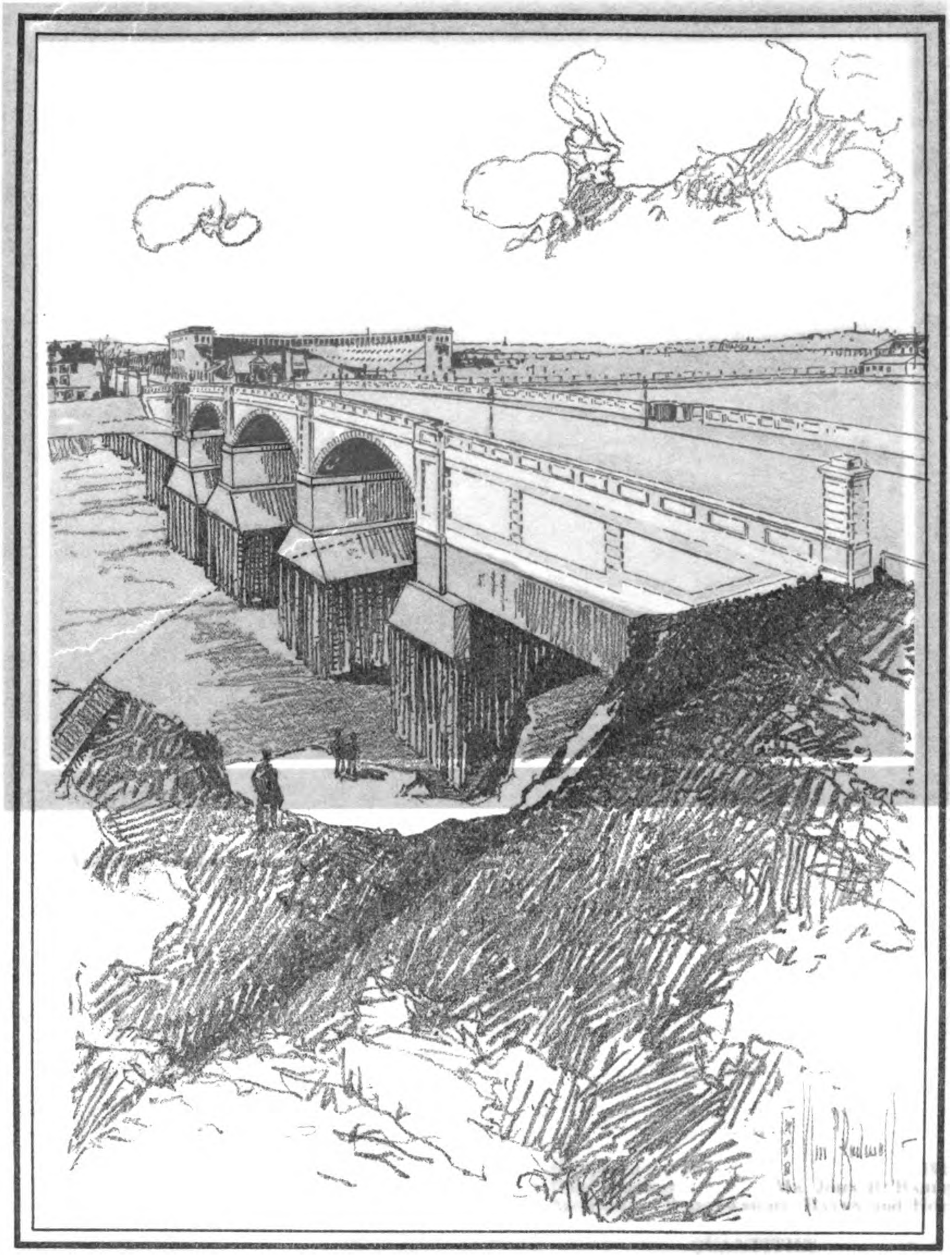
roadway and the floor of the bridge consists of a reinforced concrete slab.

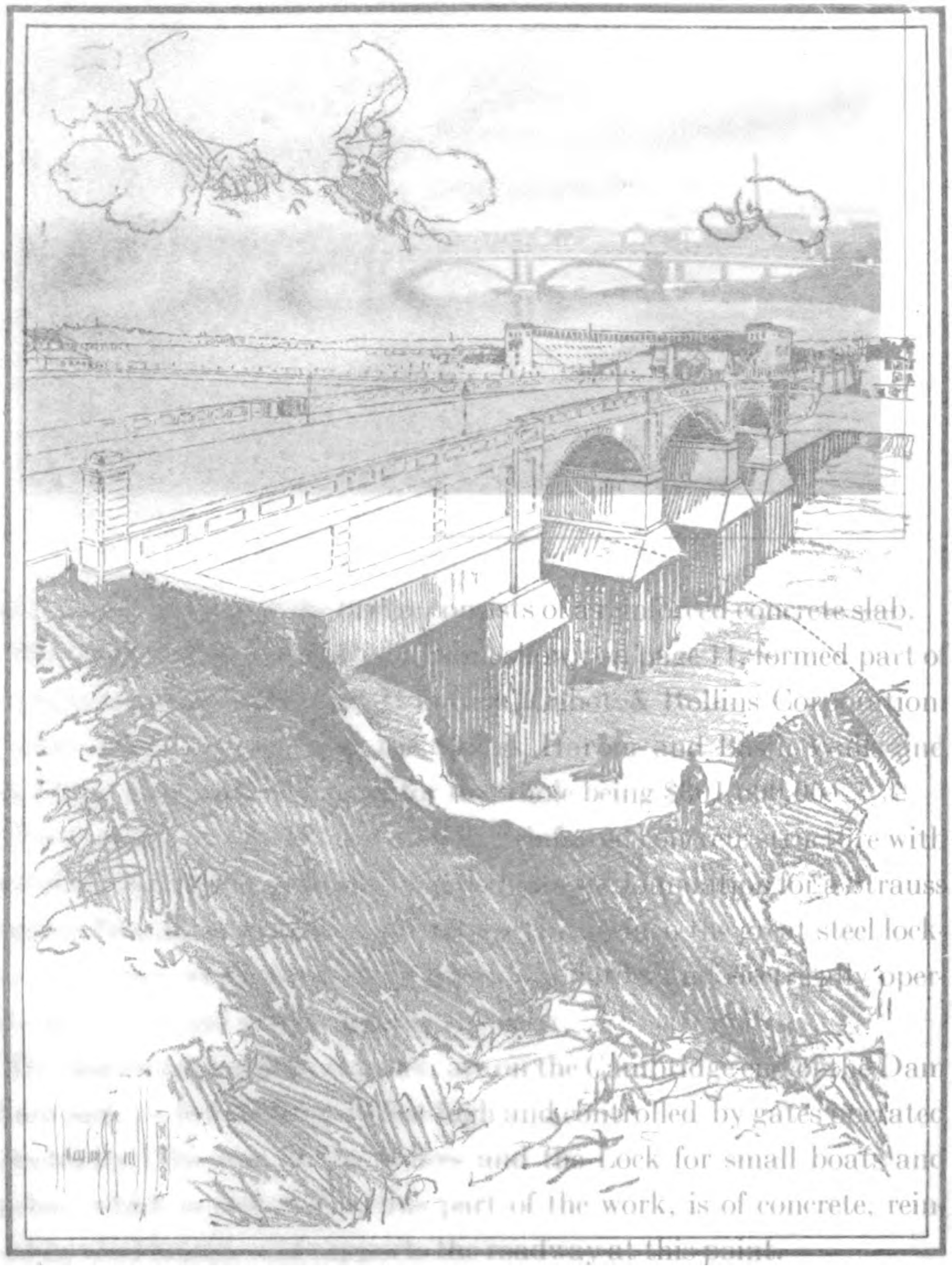
The Locks in the Charles River Dam, shown on page 11, formed part of the original contract awarded Holbrook, Cabot & Rollins Corporation, the other items covered being the Sluices, Harbor and Basin Walls and earth filling, the estimated figure for the whole being $801,600.00.

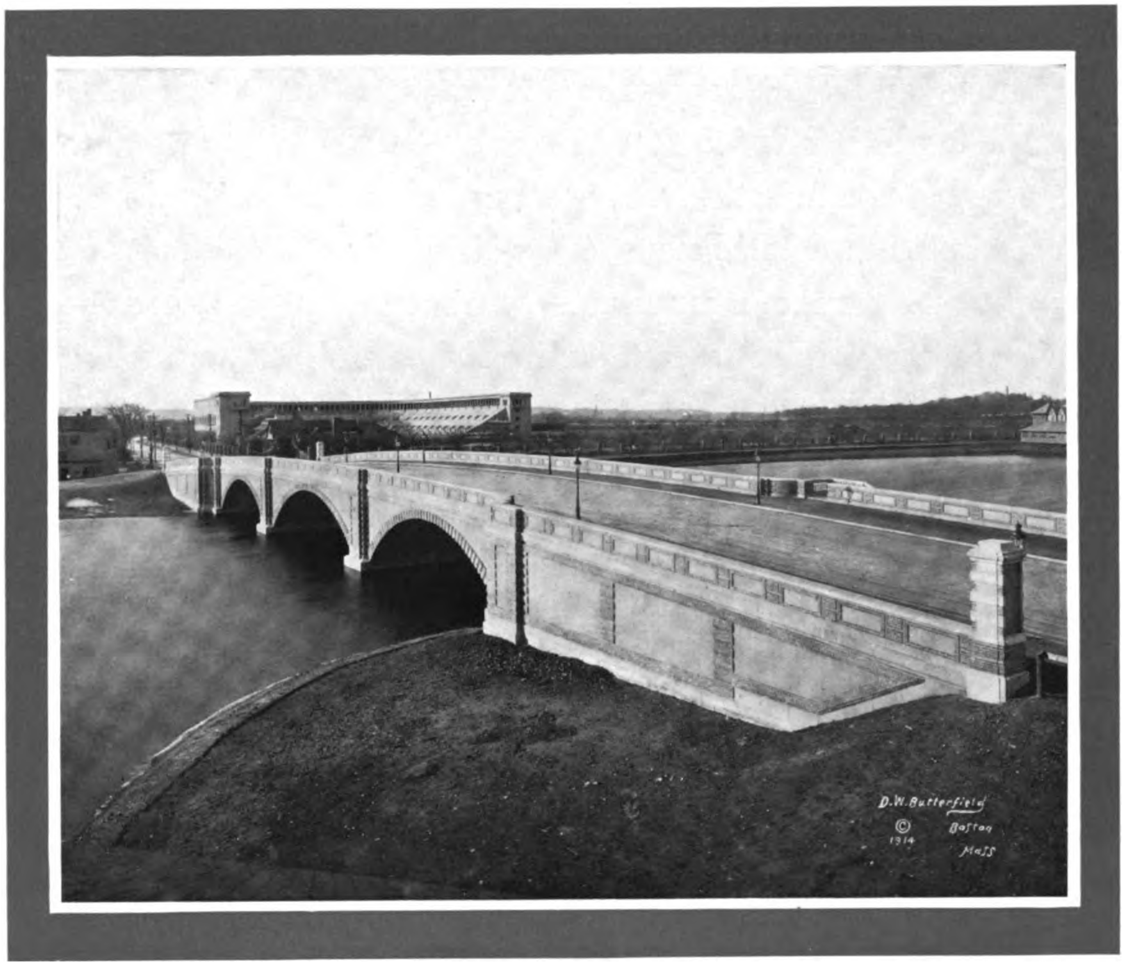
The Lock as constructed is a massive reinforced concrete structure with expansion joints, resting on piles, and includes the foundation for a Strauss Trunnion Bascule Drawbridge, the recesses into which the great steel lock-gates are drawn when the Lock is opened, bollards, and electrically operated capstans to aid vessels passing the Lock.

The sluiceways, eight in number, are on the Cambridge end of the Dam and are each 7½ feet wide by 10 feet high and controlled by gates operated by electricity. The roof of the Sluices and the Lock for small boats and launches, which is included in this part of the work, is of concrete, reinforced by steel beams, and supports the roadway at this point.

The first contract for the Charles River Dam, which is really the key structure of the entire Charles River Basin project, was awarded Holbrook,







Anderson Bridge—Charles River

Completed 1914
Chief Engineer .... Mr. John R. Rablin
Architects... Wheelwright, Haven and Hoyt

QUANTITIES

13,000 cubic yards of dredged material
2,000 piles
9,400 cubic yards of concrete
10,000 barrels of cement
100 tons of reinforcing rods

Cabot & Rollins Corporation on January 14, 1905. Actual construction on the Dam began in 1907, and the work completed in 1909 at a cost of $1,198,655.00, which included the building of the Lock. In addition to its importance as a structure, the Dam holds a prominent place in the esteem of engineers and contractors because of the difficult conditions under which it was built and because of the unusual—even spectacular—method adopted for closing the river between tides, involving, as it did, the construction of a shut-off dam and the arresting of all tidal flow over an area of 830 acres in a few seconds.

East of the Lock and west of the Sluices, both of which had previously been built within cofferdams, and between the Lock and the Sluices, the earth fill of the main portion of the Dam was to be made, the depth ranging from 10 feet at the shores to 50 feet in the deeper portions of the river, and having a minimum width of 340 feet.

After pumping out and previous to building the Lock in the cofferdam on the Boston side of the river, three lines of 6-inch grooved and splined hard yellow pine sheeting were driven, and under the Sluices in the Cambridge cofferdam four lines, for the purpose of cutting off any possible flow under these structures. Each line was driven into the hard clay underlying the river bed and the sheeting embedded 9 inches in the concrete where it came in contact with the bottom and sides of the Lock and Sluice structures. A single line of 6-inch sheeting was extended to the outer line of both the Boston and Cambridge cofferdams, this line of sheeting being located approximately in the center of the Dam and to a certain extent serving the purpose of a core-wall.

The next step in the construction of the shut-off was the placing of 83 bents, 8 feet center to center, along the line of the sheeting. These bents consisted of piling driven through to clay, each pile strongly braced to the others in that bent and further protected by batter piles, and carrying guides for the gates which were to be simultaneously dropped into place

Neponset Bridge

along the entire length of the shut-off dam when the time came to close the river. The gates were made of yellow pine, were 16 feet high, one inch less in width than the space between the bents, and each was suspended from a gallows frame built on top of the bents. Gravel and rip-rap was placed along the entire length of the dam. The day before the gates were to be dropped, each gate was tested by lowering it into position, was examined by a diver and a mark made on the guides that would show that the gate had gone to its proper bearing when finally dropped—and all was ready for the crucial moment.

According to the terms of the contract, the closing of the river had to be completed between two tides, the State being responsible for any failure of the shut-off dam to withstand the pressure of the two high tides immediately following the closing of the dam, the contractor assuming entire responsibility thereafter. October 20, 1908, was the day selected and 10 a.m. the hour set for dropping the gates and arresting the tidal flow, but on account of a strong northeast wind backing up the tide, the closing was delayed one hour. At 11 o'clock forty men took their places on a staging built along the top of the guides. On the signal being given by the Hon. Curtis

Guild, Jr., Governor of the State, and relayed to the waiting men by means of a steam whistle on shore, the ropes suspending the gates were cut with axes and in less than two minutes all the gates were down, the holding-down pieces put in place and the wedges driven home. The Charles River Basin had been converted from a tidal to a fresh water basin.

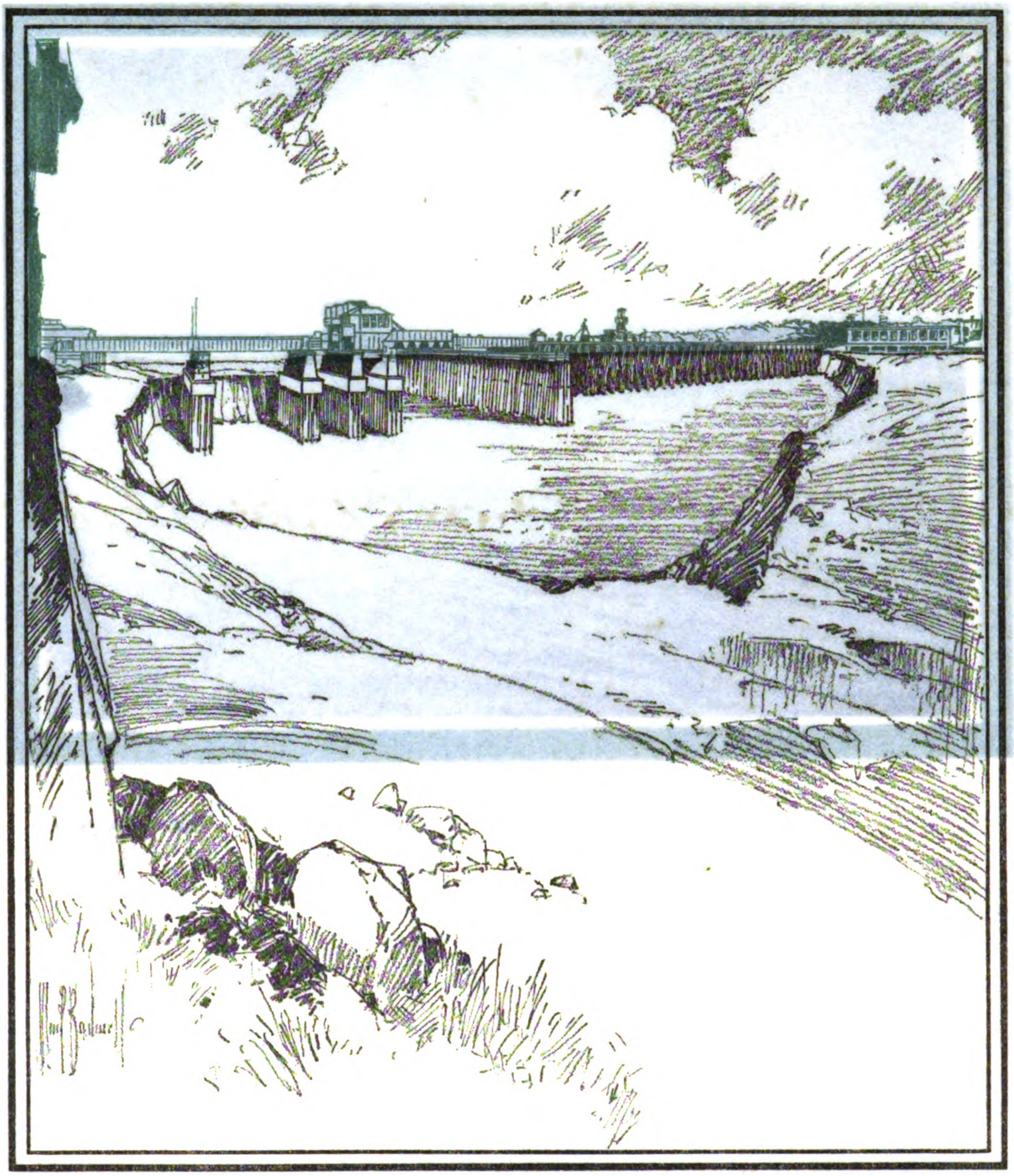
As soon as the gates were in place, three rehandlers began to pile material against them. Additional material was brought in scows from dredges excavating in the basin and dumped within reach of the rehandlers. The remainder of the work consisted of completing the fill and putting the face walls into position.

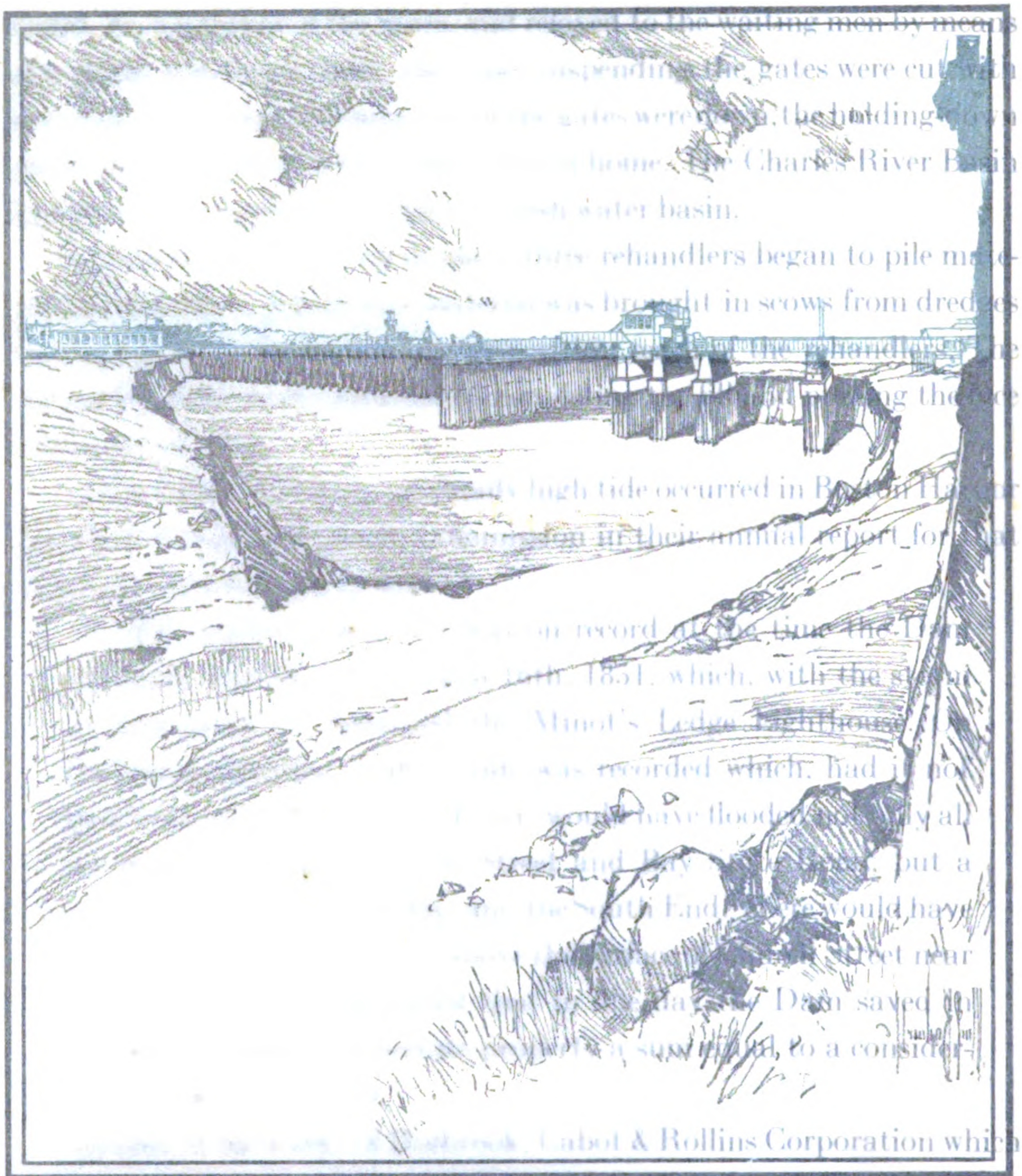
In December of 1909 an unusually high tide occurred in Boston Harbor and the Charles River Basin Commission in their annual report for that year have the following to say:

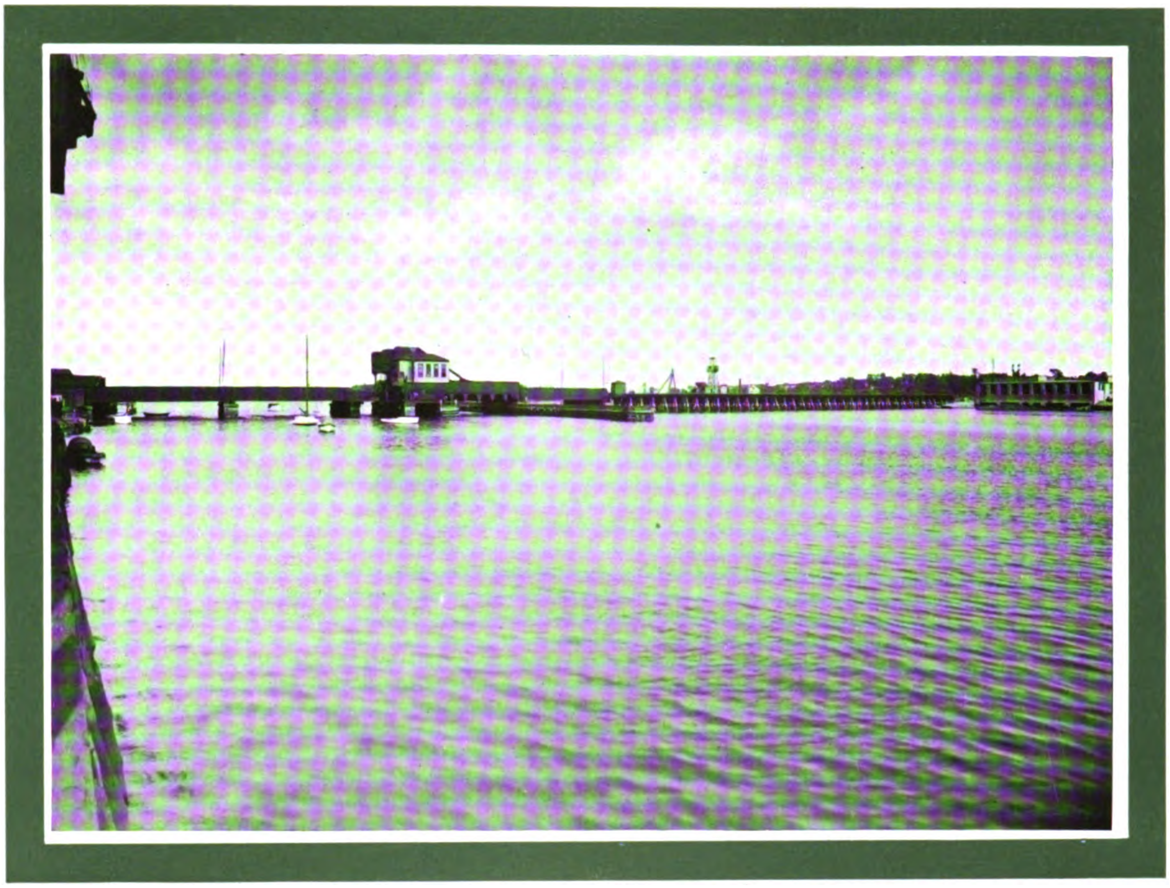
> "The highest tide which was on record at the time the Dam was built, was the tide of April 16th, 1851, which, with the storm accompanying it, destroyed the Minot's Ledge Lighthouse. On Christmas morning, 1909, a tide was recorded which, had it not been kept out of the Charles River, would have flooded not only all the basements along Beacon Street and Bay State Road, but a large portion of the Back Bay and the South End. There would have been nearly five feet of water above the surface of Church Street near Park Square. It is estimated that in one day the Dam saved in damage to public and private property a sum equal to a considerable portion of its cost."

Another of the works of Holbrook, Cabot & Rollins Corporation which has served both to beautify and to improve that portion of the cities of Boston and Cambridge which borders on the Charles, is the Anderson Bridge, views of which are shown on pages 20 and 21.

This bridge, built in 1913 and 1914, was in the main a gift of Mr. Lars Anderson, Boston and Cambridge paying only for their respective







Neponset Bridge

Built 1907
Chief Engineer.............Mr. F. S. Curtis

QUANTITIES

97,000 linear feet of piling
3,600 cubic yards of masonry

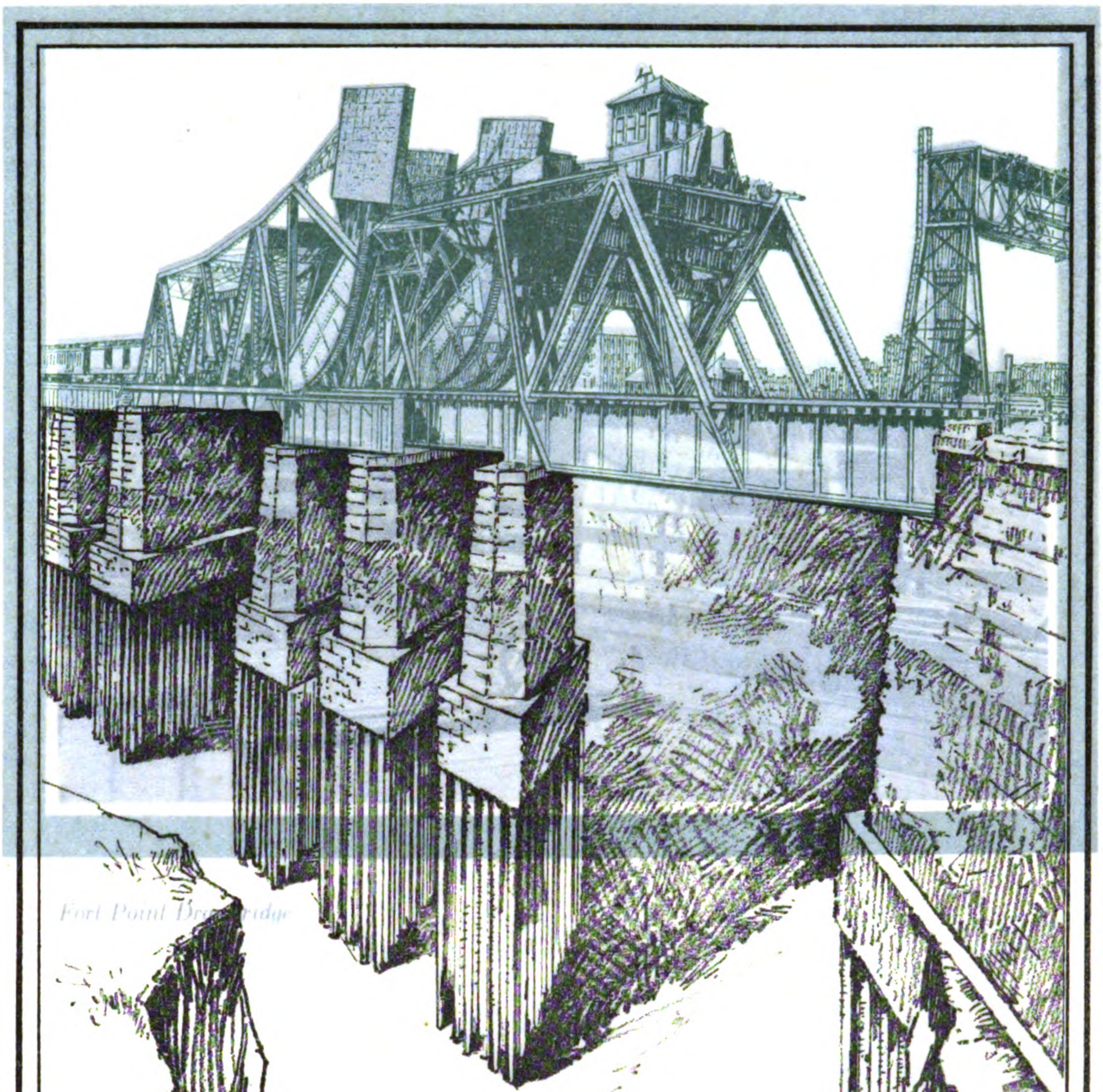
approaches. Mr. John R. Rablin was engineer, and Messrs. Wheelwright, Haven and Hoyt, the architects.

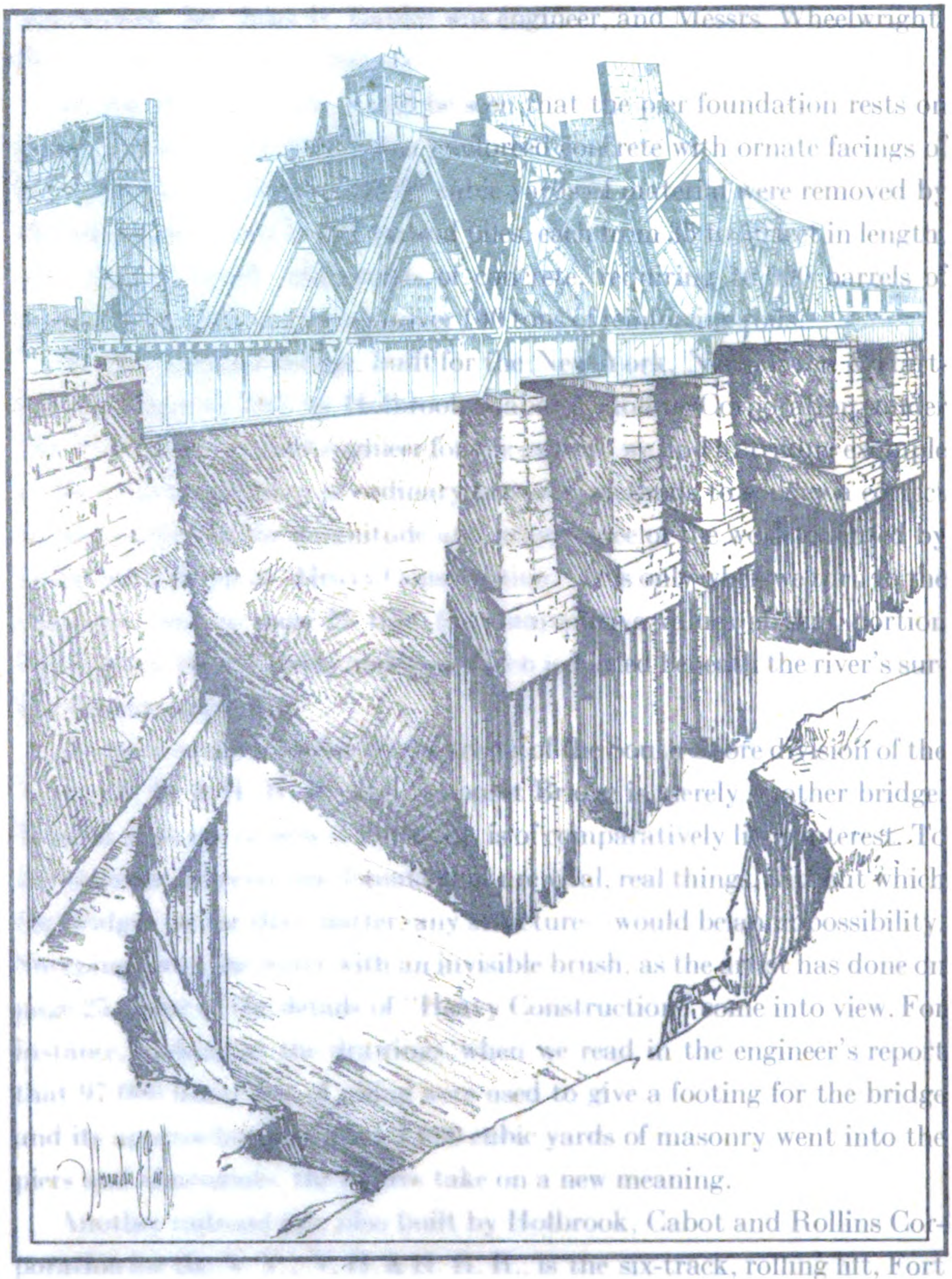
In the phantom view it will be seen that the pier foundation rests on piling, the structure itself being reinforced concrete with ornate facings of brick. In its construction 13,000 cubic yards of material were removed by dredging, and nearly two thousand piles, each from 35 to 50 feet in length, were driven; 9,400 cubic yards of concrete, requiring 10,000 barrels of cement, were used, as were also over 100 tons of reinforcing rods.

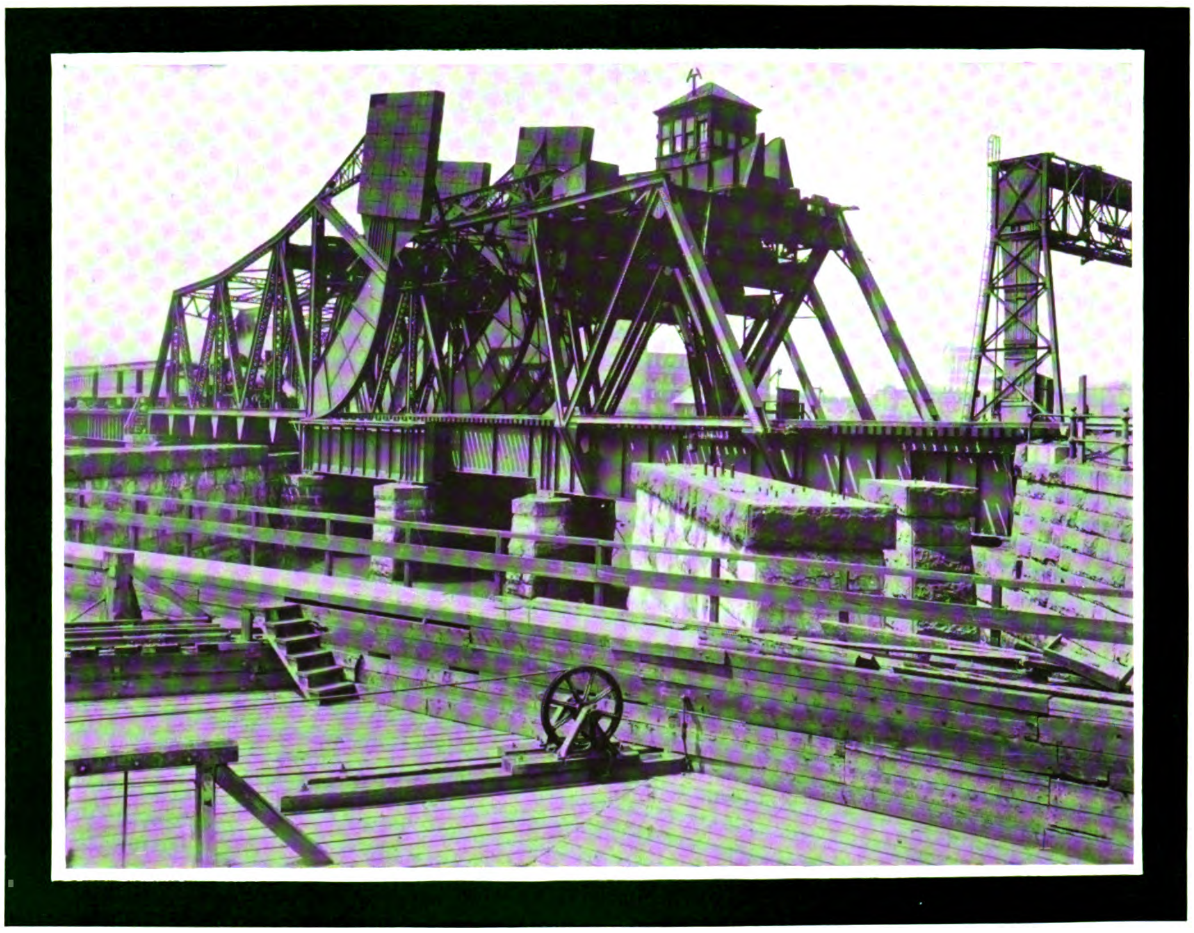
In the Neponset Bridge, built for the New York, New Haven & Hartford Railroad in 1907 by Holbrook, Cabot & Rollins Corporation, under Mr. F. S. Curtis as chief engineer for the owners, we find a striking example of the total inadequacy of ordinary pictorial methods to convey a correct understanding of the magnitude and importance of the work executed by a firm specializing in "Heavy Construction." It is only when we turn to the phantom view on page 25 that the comparative values of that portion which meets the eye today and that which is buried beneath the river's surface become apparent.

To the average traveller on the trains of the South Shore division of the N. Y., N. H. & H. R. R., the Neponset Bridge is merely another bridge. What it rests on, or how it was built, is of comparatively little interest. To the engineer, however, the foundations are vital, real things, without which the bridge—or for that matter, any structure—would be an impossibility. Sweeping away the water with an invisible brush, as the artist has done on page 25, some of the details of "Heavy Construction" come into view. For instance, looking at the drawings, when we read in the engineer's report that 97,000 linear feet of piling were used to give a footing for the bridge and its approaches, and that 3,600 cubic yards of masonry went into the piers and abutments, the figures take on a new meaning.

Another railroad job, also built by Holbrook, Cabot and Rollins Corporation for the N. Y., N. H. & H. R. R., is the six-track, rolling lift, Fort







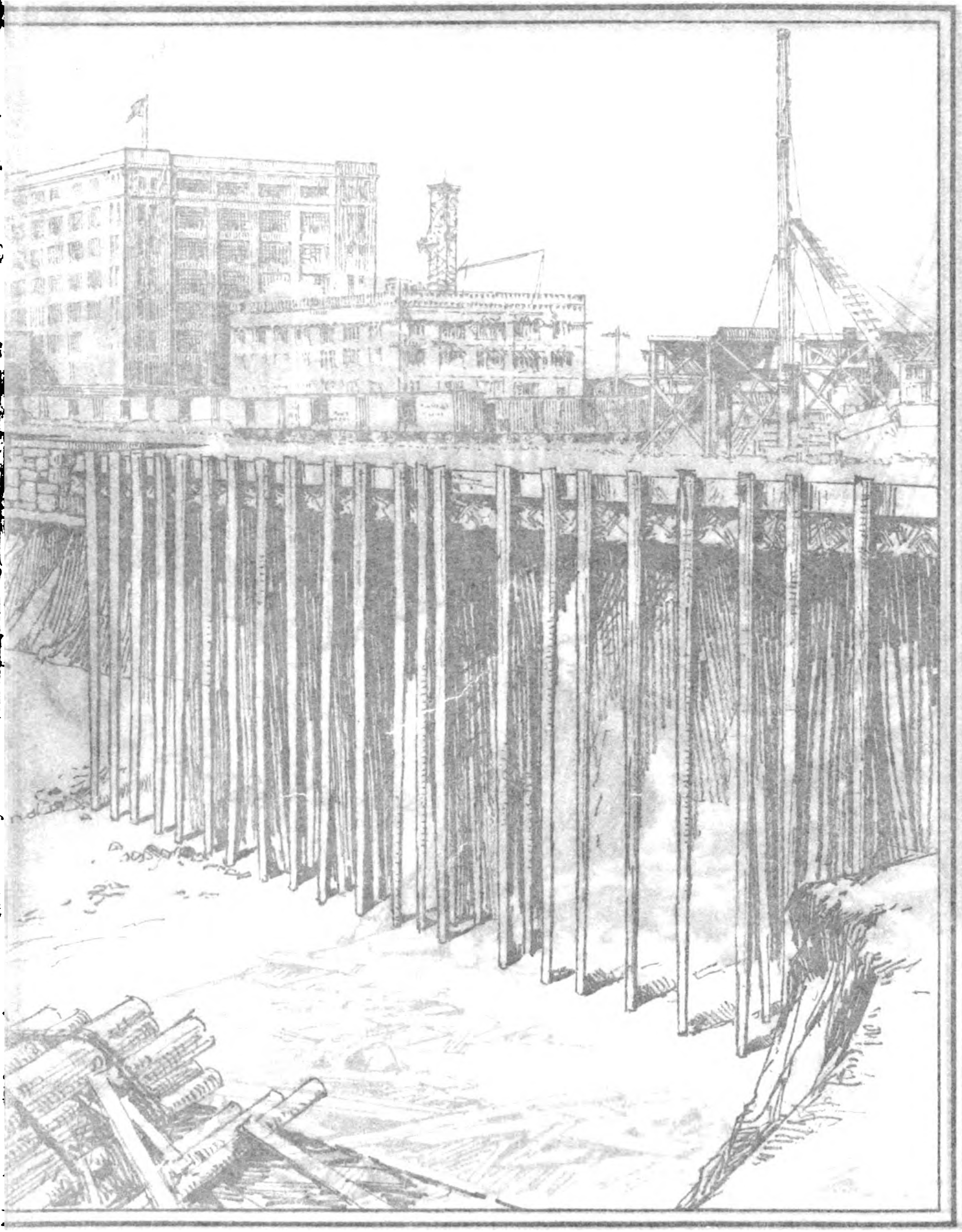
Fort Point Drawbridge

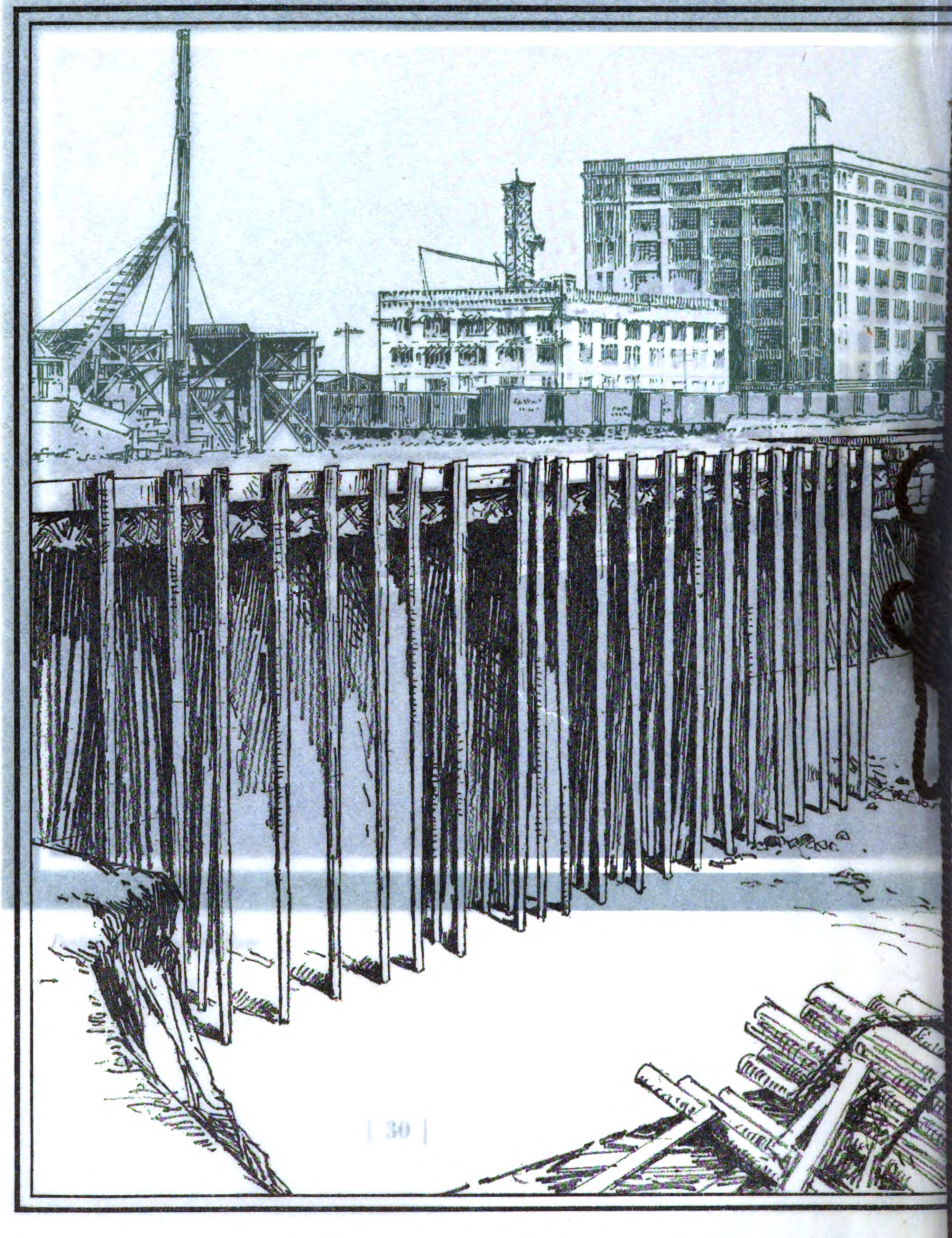
Completed 1900
Chief Engineer.............. MR. F. S. CURTIS

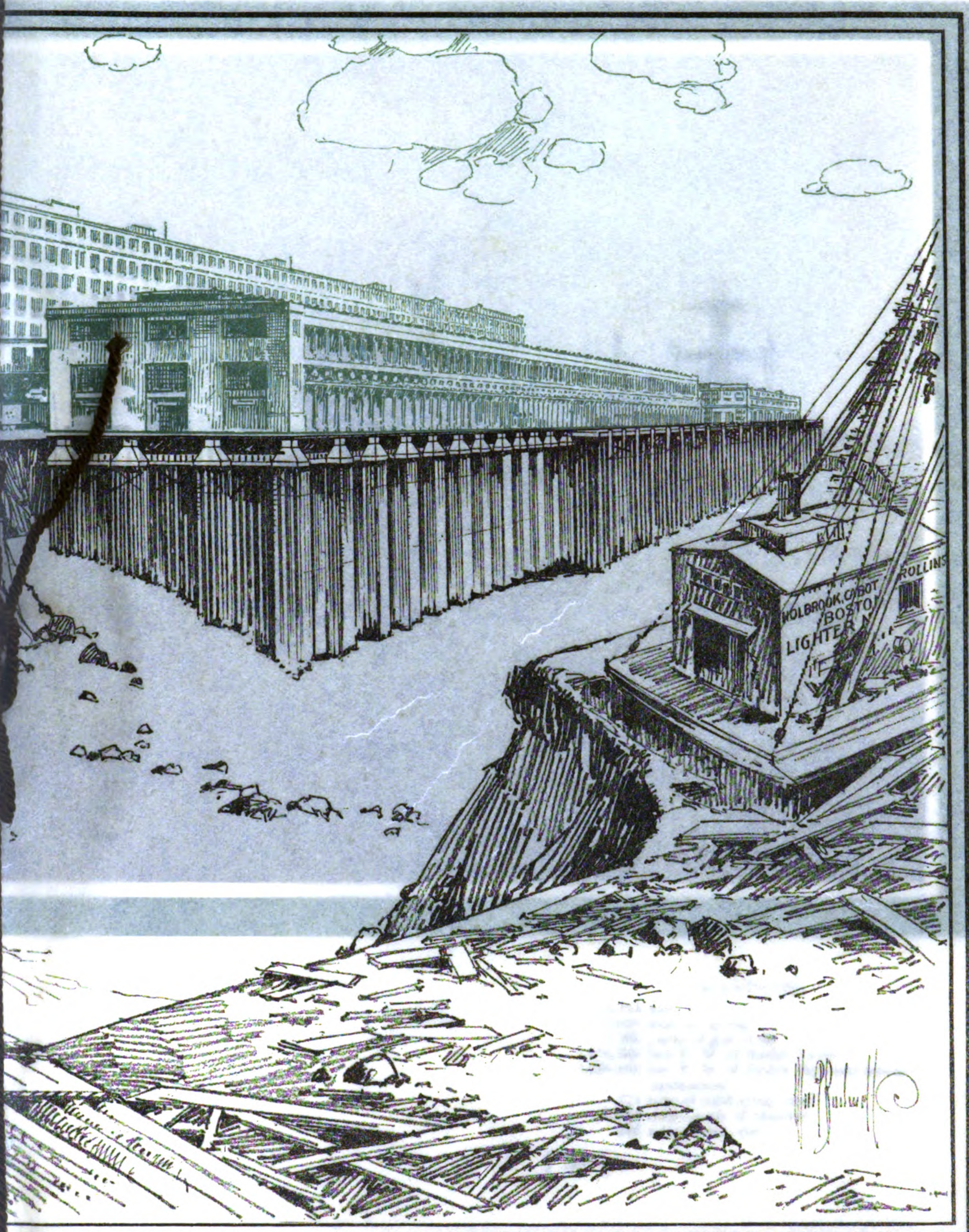
QUANTITIES

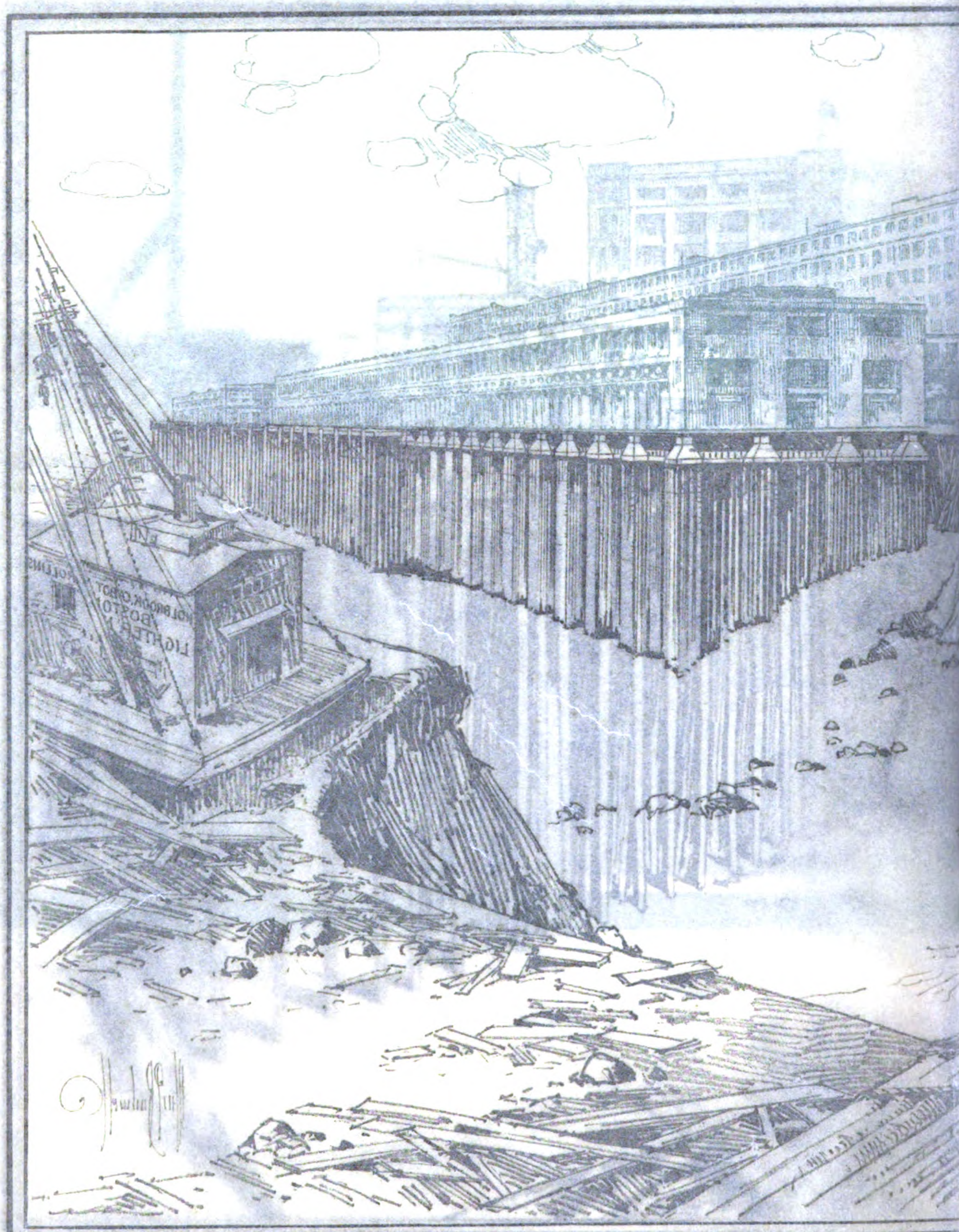
25,000 cubic yards of dredged material
11,368 cubic yards of masonry in piers
16,000 cubic yards of rip-rap
304,000 linear feet of piling

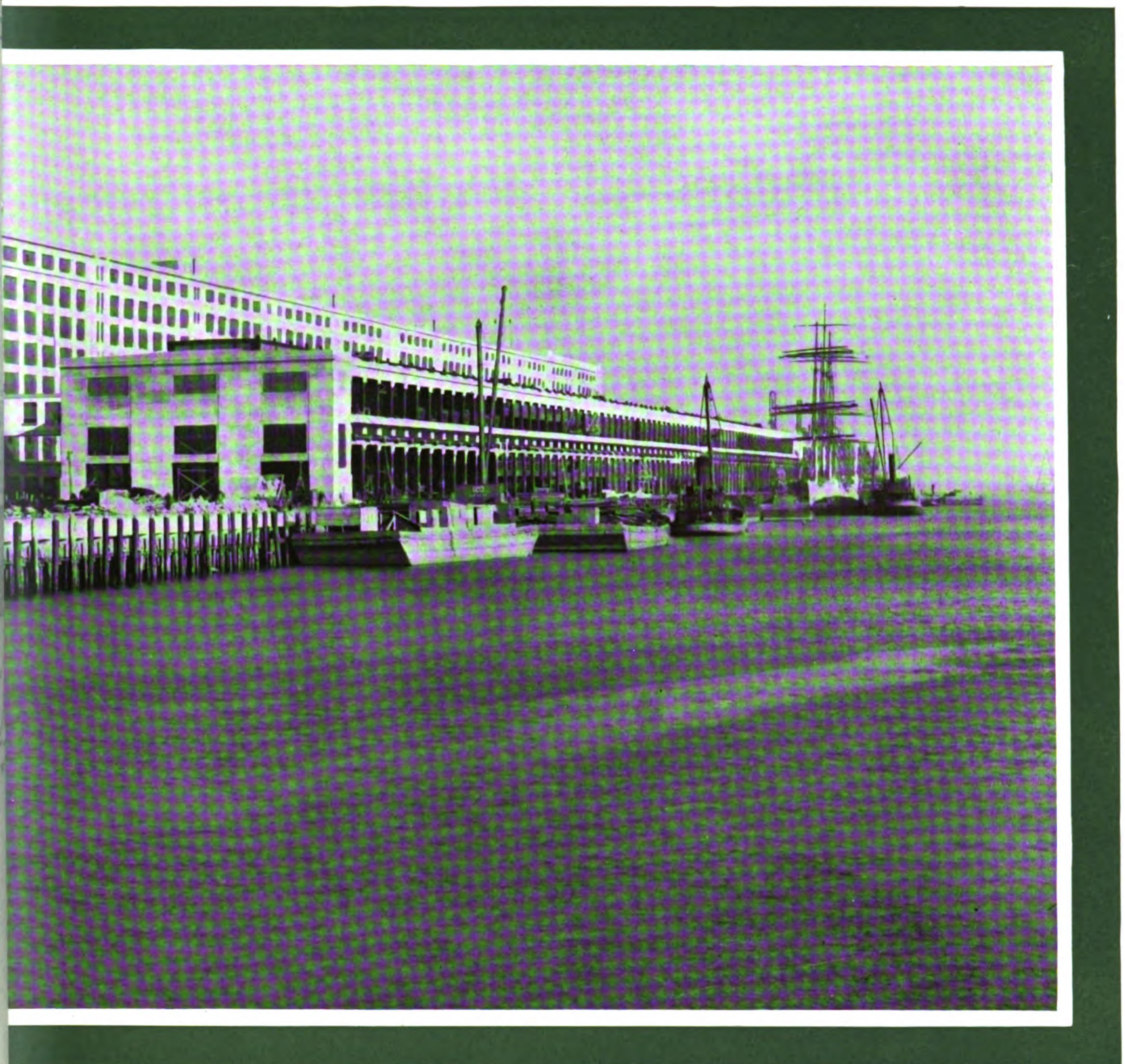
Boston Army Supply Base






HOLBROOK, CABOT
ROLLINS
BOSTON
LIGHTER





QUANTITIES

23,154	piles
6,636	tons of rip-rap
9,200	yards of gravel fill
1,076,000	feet B. M. of timber forms
1,289,000	feet B. M. of timber caps and braces (permanent)
771	tons of reinforcing steel
30,853	cubic yards of concrete
388	tons of iron, etc.

Cambridge Bridge

settled to such an extent that traffic had to be cut down to a single track and plans for a new bridge were called for.

The present structure, which is 1,387 feet long, is in five spans, the draw span being 330 feet. The work on the foundations began April 20, 1916, and was finished August 9, 1917; 57,114 cubic yards of masonry being placed in all.

The terms of the contract between Holbrook, Cabot & Rollins Corporation and the owners, were somewhat novel. The contractor guaranteed that the cost of the foundations, according to the plans submitted, would not exceed $875,000.00, that any excess cost above that sum was to be paid by the contractor, and that any saving in cost would be divided equally between the contractor and the railroad company. For his services the contractor was to be given a fixed fee of $80,000.00. This plan worked out most satisfactorily to all parties concerned.

The final and accepted plans for the bridge called for rectangular open-crib caissons, two abutments on gravel foundation, three open cribs sunk to hard gravel, 90 feet, 130 feet, and 131 feet, respectively, below water, and the fourth pier to be built on three pneumatic foundations sunk to solid rock, 60 feet to 90 feet below water.

Problems immediately began to develop. For instance, how were the concrete "cutting edges" of the cribs, each 42 feet by 99 feet in outline and 13 feet high, containing 700 cubic yards of heavily reinforced concrete and weighing 1,500 tons, to be built? With the necessary caisson sides built on to the cutting-edge section, the combined structure drew 30 feet of water and there were no launching ways available for that depth of water. A ship railway, with an extreme draught of 20 feet, a plan for using the air spaces in the dredging wells for flotation, with a corresponding reduction in draught and the completion of the caisson sides after the crib had been towed to the site of the work, solved this problem.

To control the cribs as they sank, by using jets, excavating in some pockets and loading others with concrete and stone, until finally the crib sunk to grade and was straightened up, offered a multitude of problems, large and small.

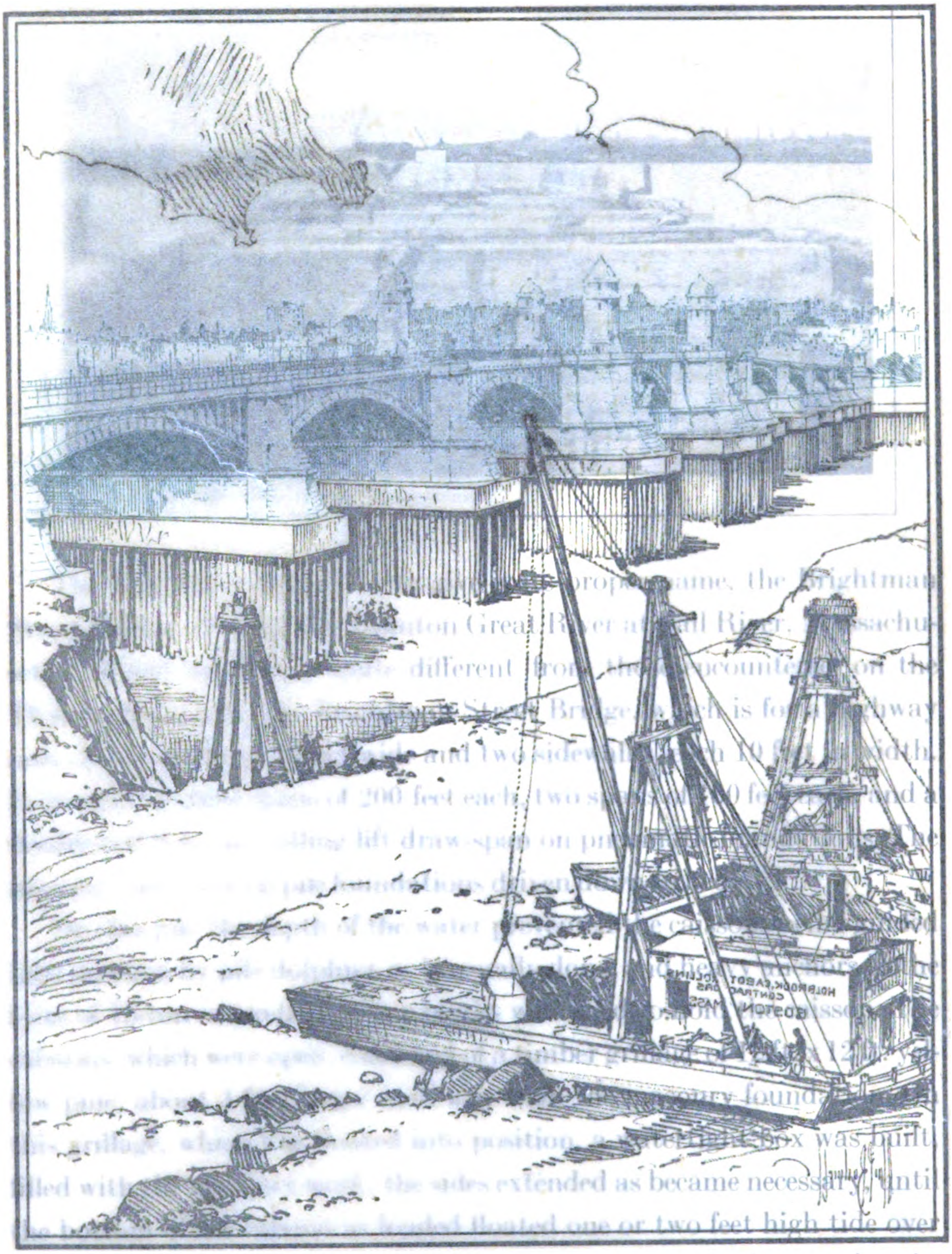
Cambridge Bridge—Main Construction

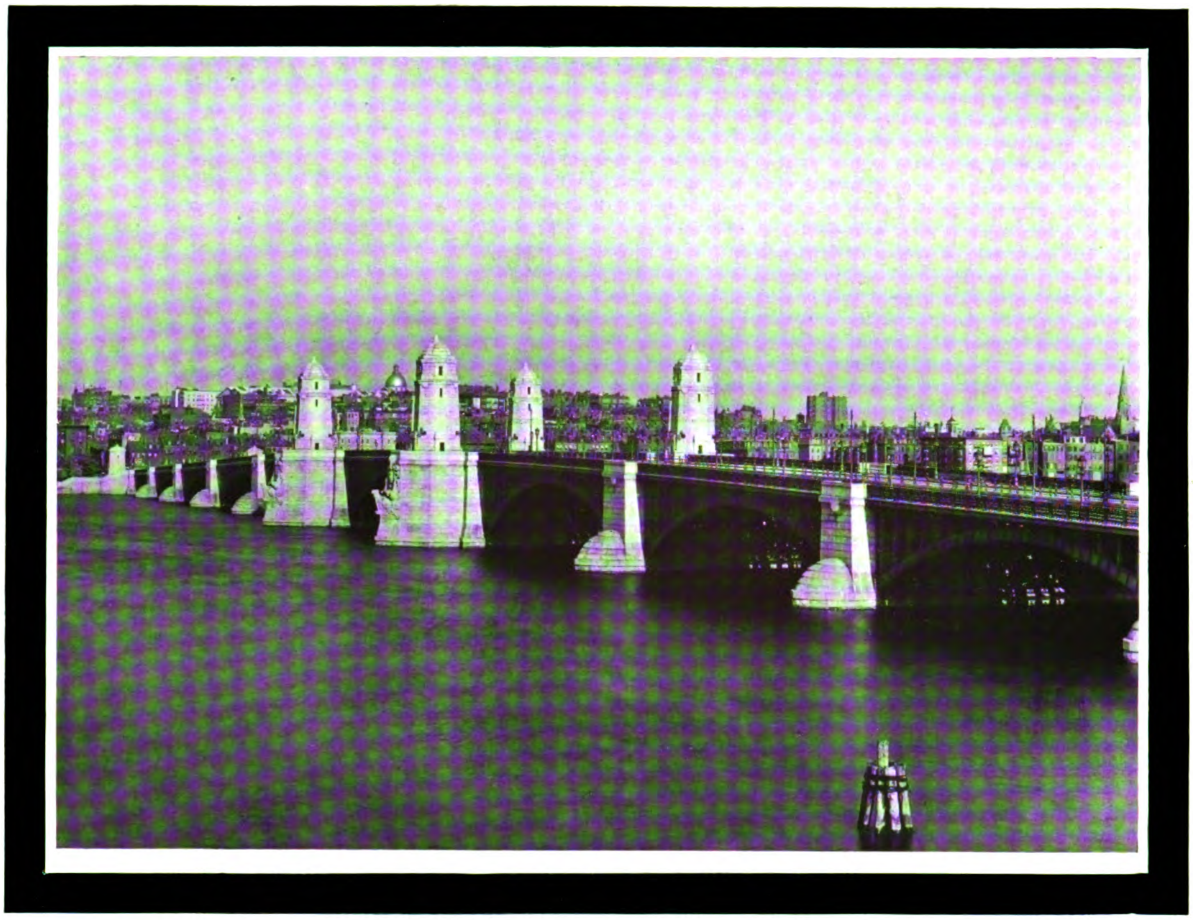
Cambridge Bridge—Piers Under Construction

The Fall River Bridge, or to give it its proper name, the Brightman Street Bridge, crossing the Taunton Great River at Fall River, Massachusetts, offered conditions quite different from those encountered on the Thames River job. The Brightman Street Bridge, which is for a highway only, has a roadway 50 feet wide and two sidewalks, each 10 feet in width. It consists of three spans of 200 feet each, two spans of 100 feet each, and a double-leaf Scherzer rolling lift draw-span on pneumatic foundations. The masonry piers rest on pile foundations driven down to bed rock.

On this job, the depth of the water prevented the caissons being guided into position by pile dolphins as is usually done, and heavy anchors in the form of 15-ton concrete mooring blocks were used to hold the caisson. The caissons, which were open, consisted of a timber grillage of 12 ft. x 12 ft. yellow pine, about 4 feet larger each way than the masonry foundation. On this grillage, which was floated into position, a watertight box was built, filled with the masonry work, the sides extended as became necessary, until the bottom of the caisson as loaded floated one or two feet high tide over the tops of the piles it was to rest on. When lined up both ways by the


HOLBROOK, CABOT ROLLINS
CONTRACTORS
BOSTON MASS



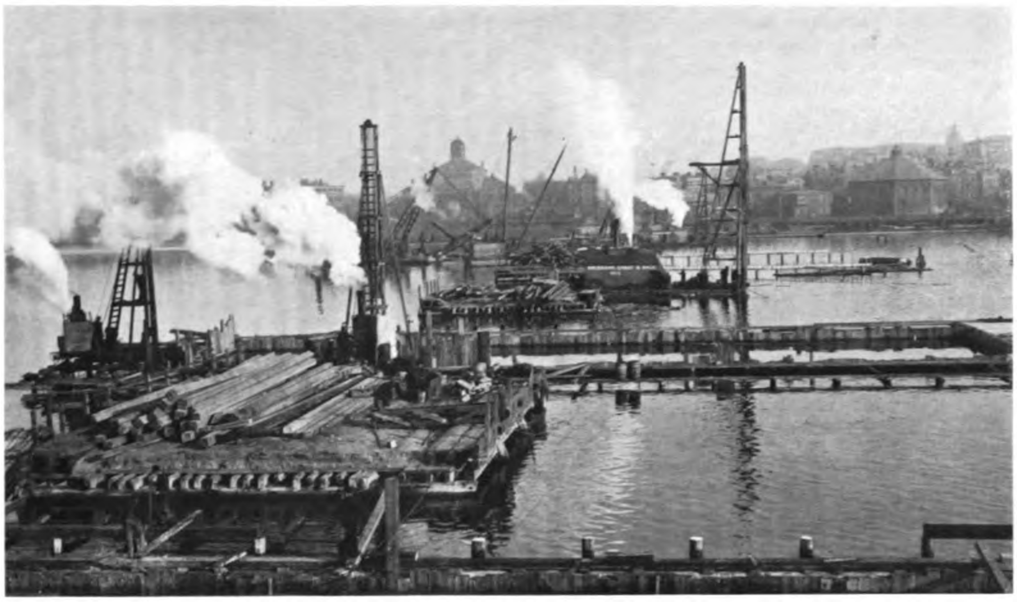


Cambridge Bridge

Completed 1907
Chief Engineer .... MR. WILLIAM JACKSON
Architect .... MR. JOHN E. CHENEY
Collaborator ... MR. EDMUND M. WHEELWRIGHT

QUANTITIES

200,000 cubic yards of excavation
19,122 piles
75,000 cubic yards of concrete
12,000 cubic yards of stone masonry
1,475,000 feet B. M. of lumber

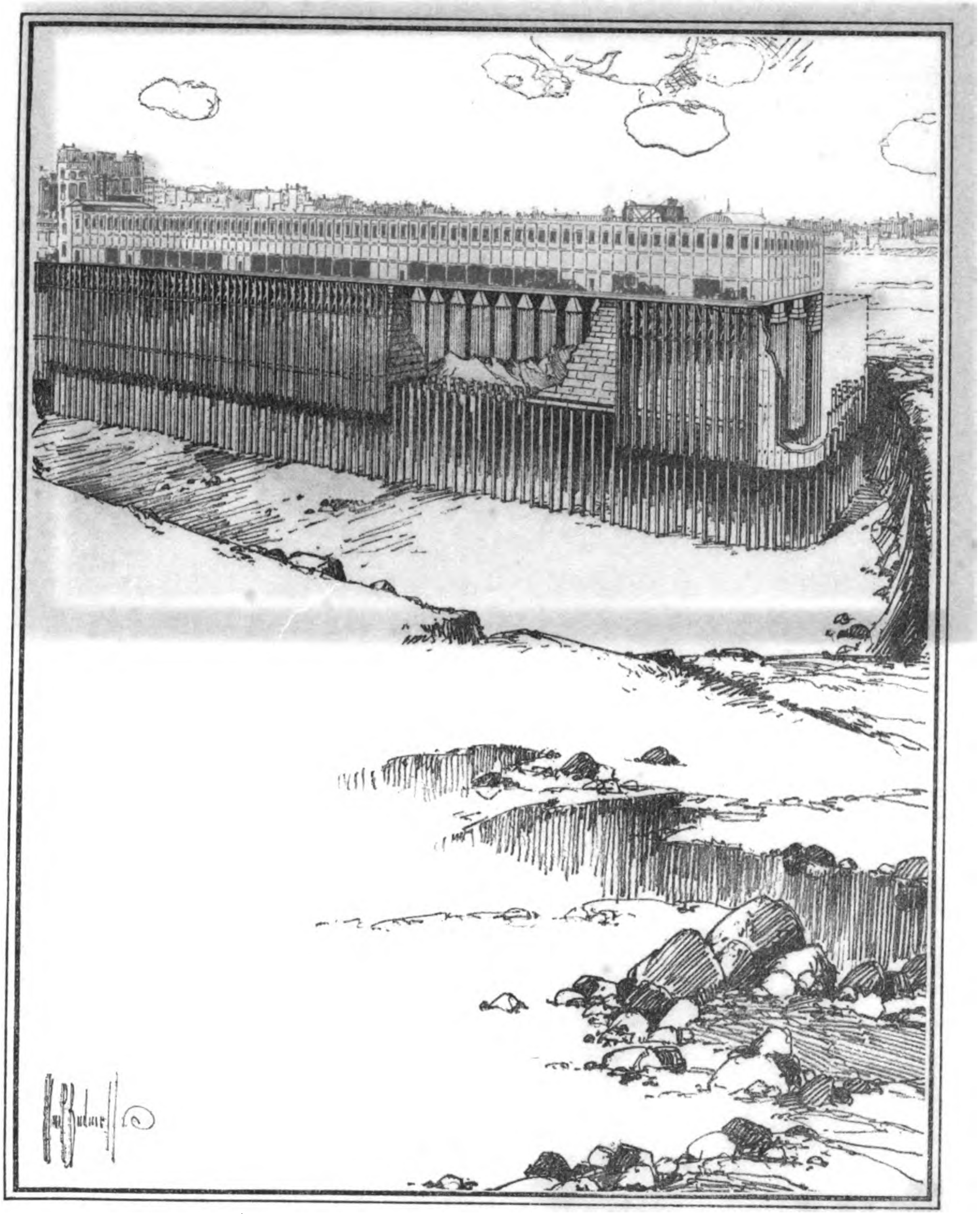


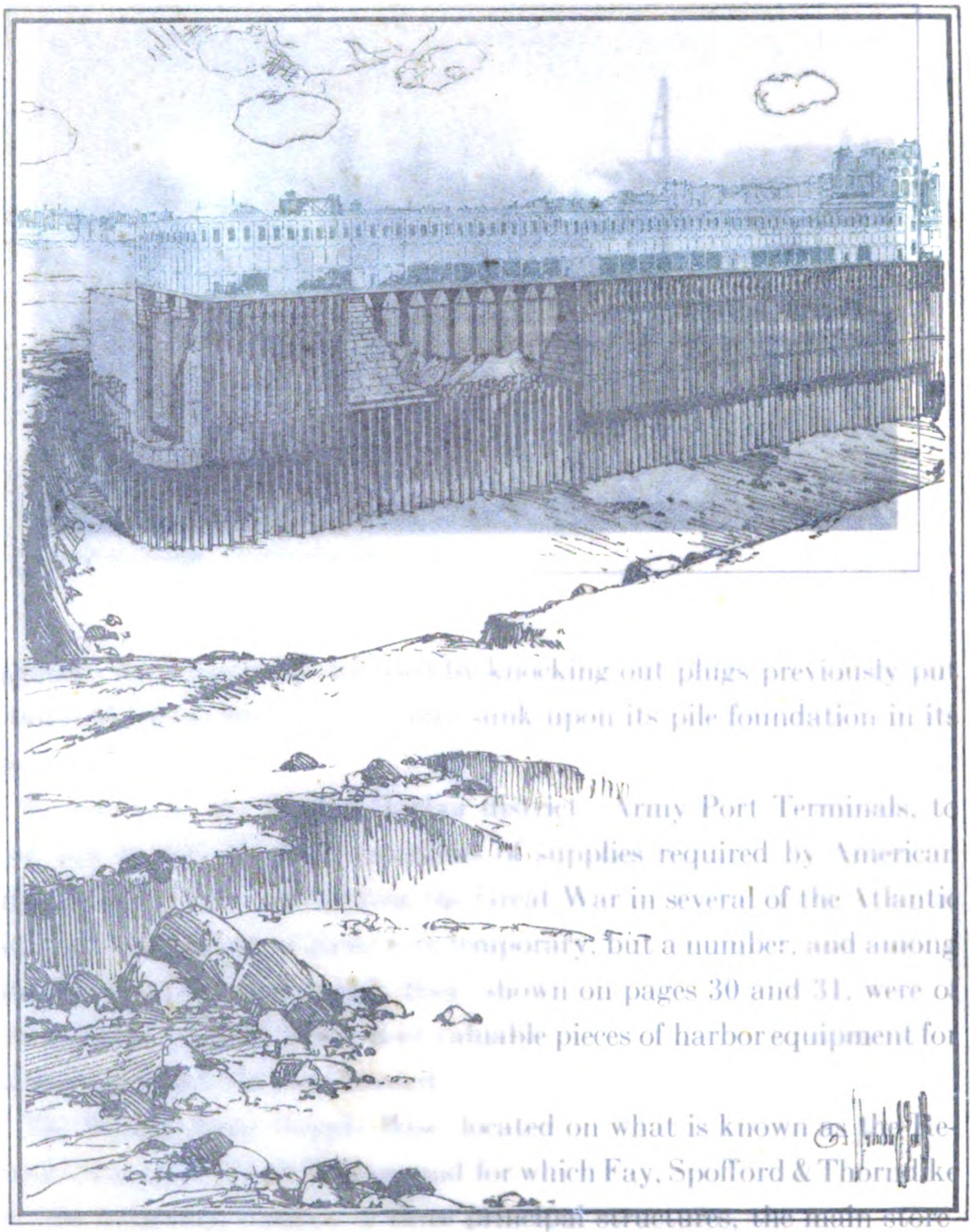
Cambridge Bridge—Construction Scene

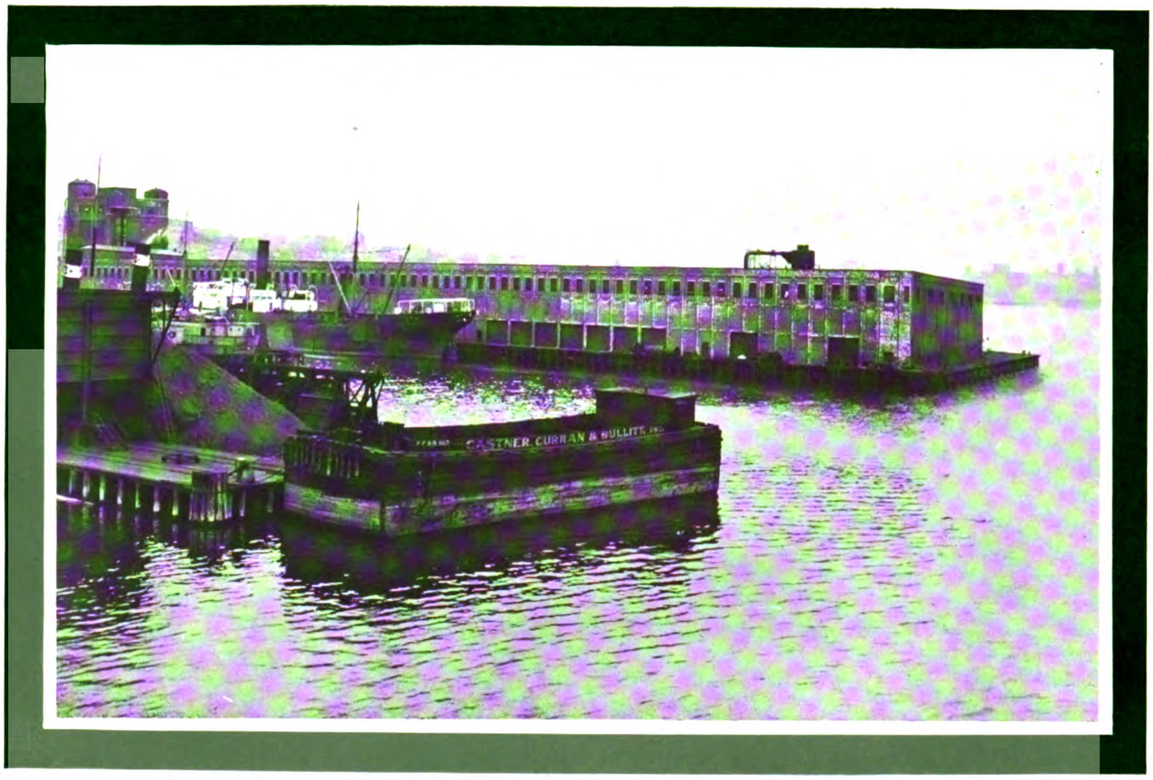
engineers, the caisson was scuttled by knocking out plugs previously put in below the water line, and the pier sunk upon its pile foundation in its true position.

To return to the Boston Harbor district—Army Port Terminals, to store and handle the vast quantities of supplies required by American overseas forces, were built during the Great War in several of the Atlantic and Gulf cities. Many of them were temporary, but a number, and among them the Boston Army Supply Base, shown on pages 30 and 31, were of such design as to make them most valuable pieces of harbor equipment for the ports in which they are located.

The Boston Army Supply Base, located on what is known as the Reserved Channel in South Boston, and for which Fay, Spofford & Thorndike were the engineers, consists of three principal structures, the main storehouse is an eight-story reinforced concrete building, 126 feet wide and 1,638 feet long, and containing 1,651,100 square feet of floor area. Joined to this storehouse by bridges, crossing a paved street 86 feet wide in which run







Revere Sugar Refinery Pier

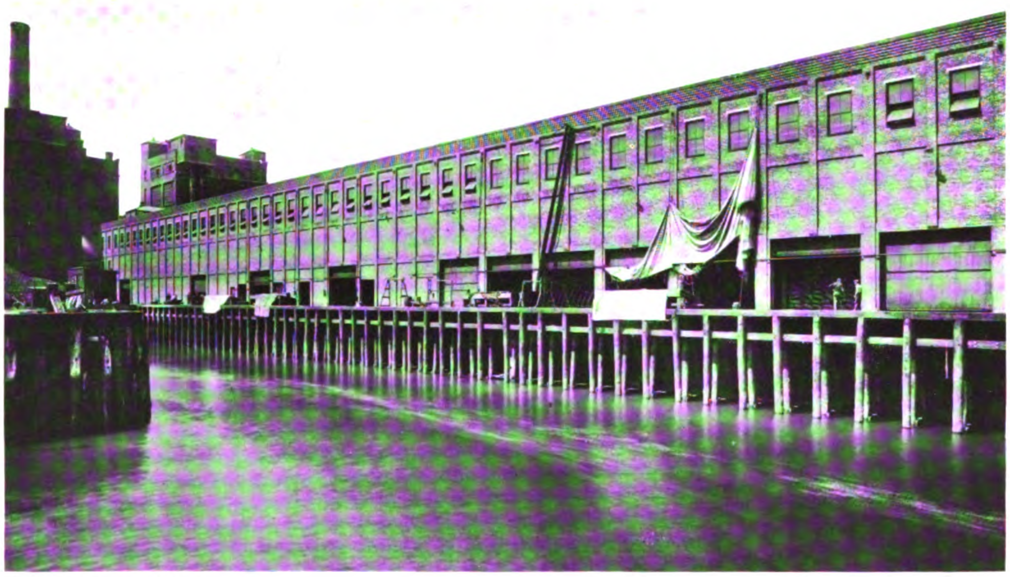
Built 1918
Chief Engineer .... Mr. H. S. Adams

QUANTITIES

6,506 piles
40,000 tons of masonry—split granite
30,000 cubic yards of dredged material
50,000 cubic yards of fill

railroad tracks, is the wharf shed. This wharf shed is 100 feet wide and 1,638 feet long and two stories high. It has a wooden pile and reinforced concrete substructure on which rests the steel frame of the shed. At the outer end of the pier is the so-called pier shed, used by the United States Navy during the war as a storehouse, and consisting of twin buildings, each 100 feet wide, 924 feet long, and three stories high, connected by bridges and built of reinforced concrete. The floor area of the wharf shed is approximately 360,000 square feet, and that of the pier shed about 580,000, giving the main buildings of the Terminal a total floor area of 2,600,000 square feet. In all, 35,000 piles were driven on this job.

The wharf shed, the substructure of which was constructed by Holbrook, Cabot & Rollins Corporation, was built for the greater part over the water, the old bulkhead running just outside the inner wall of the shed. This substructure consists of transverse concrete walls carrying the longitudinal beams and the concrete floor, the walls spanning between the pedestals resting on timber pile groups. Additional piles were spaced between



Revere Sugar Refinery

the pedestal groups so as to form cross bents and to carry part of the load of the main floor of the wharf.

The outer pedestal groups of piles, adjoining the 35-foot channel which was dredged to facilitate the docking of large cargo-carriers, transports, etc., consist of sixteen piles 2 feet and 4 inches between centers and cross-braced at the top. The remainder of the pier deck was carried on piling driven 3 feet and 8 inches between centers, except where the steel pillars of the super-structure rested, the piling at those points being driven closer together. On the face of the dock, fender piles were driven.

From the face of the dock to the inner edge of the outer wall of the shed, the transverse concrete walls were 18 inches thick, the wall for the remainder of the dock's width being 14 inches thick. An interesting detail is the embedment of the rails for the railway tracks, running along the capsill of the wharf, directly in the concrete which forms the floor.

One of the most beautiful pieces of work constructed by Holbrook, Cabot & Rollins Corporation is the Cambridge Bridge, or as it is sometimes called, the West Boston Bridge, across the Charles River and located on the Charles River Basin about midway between the Charles River Dam and the Harvard Bridge. It is an interesting and somewhat remarkable coincidence that the contracts for the Cambridge, Charles River, and Anderson Bridges, the only bridges across the river which, while recognizing the importance of their utilitarian functions, are at the same time beautiful enough to be sources of pleasure to the visitor, were all awarded to Holbrook, Cabot & Rollins Corporation, although the architects and chief engineers were different on each job.

The Cambridge Bridge, pictures of which are shown on pages 32 to 36, was built under the supervision of Mr. William Jackson as chief engineer and cost about $3,000,000.00. The plans were produced in the office of the City Engineer of Boston, with the late John E. Cheney directly in charge and with the collaboration of Edmund M. Wheelwright as architect.

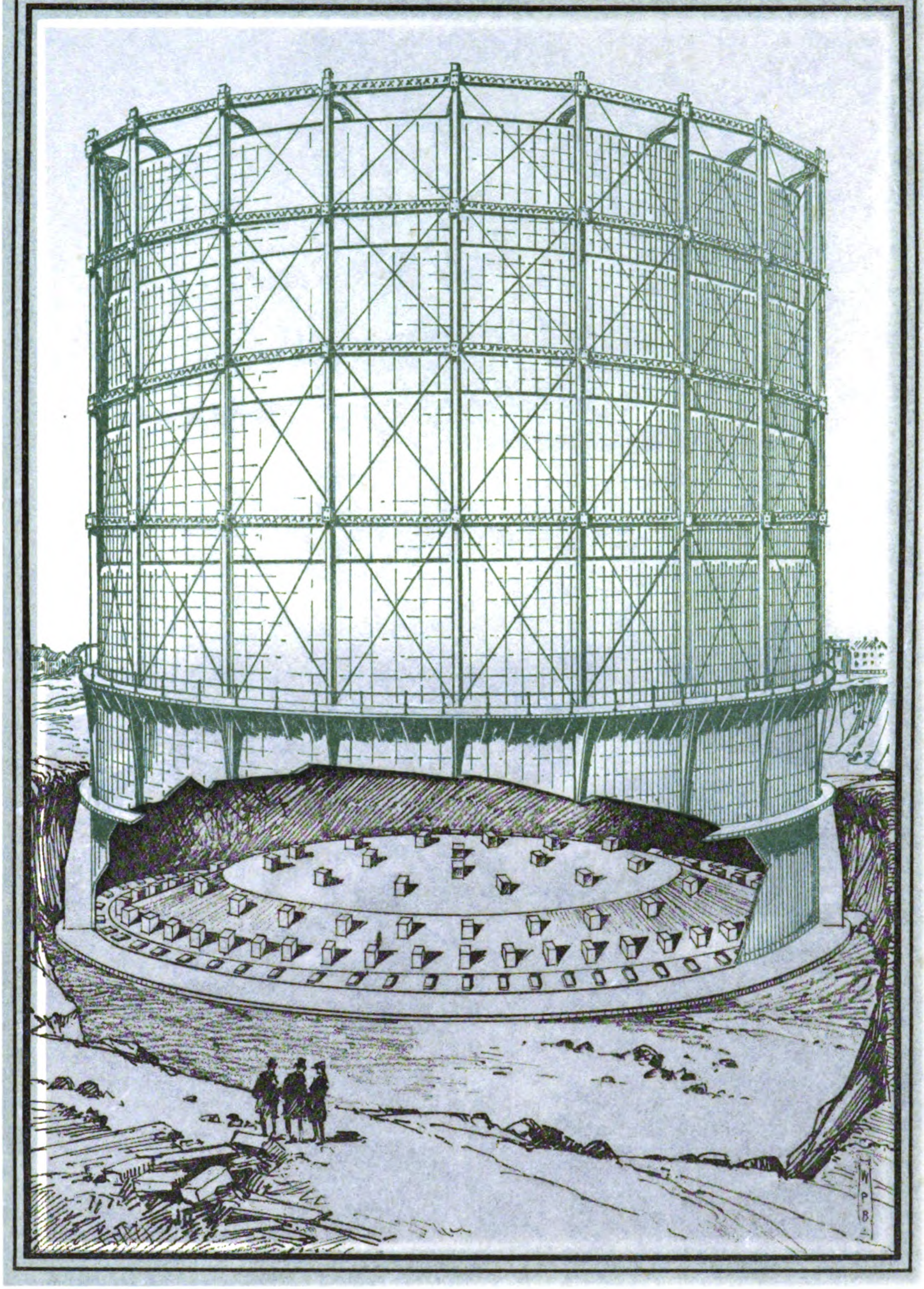
The Bridge, which is by far the most ornate structure crossing the river and compares favorably with any bridge of its type in the world, consists of eleven spans of two-hinged arched plate girders resting on stone piers and with the roadway supported on vertical steel columns rising from the arched girders. The large center piers were made hollow in order to reduce the weight on the foundation piles, which are driven to hard clay at a depth of about 50 feet below the surface of the water.

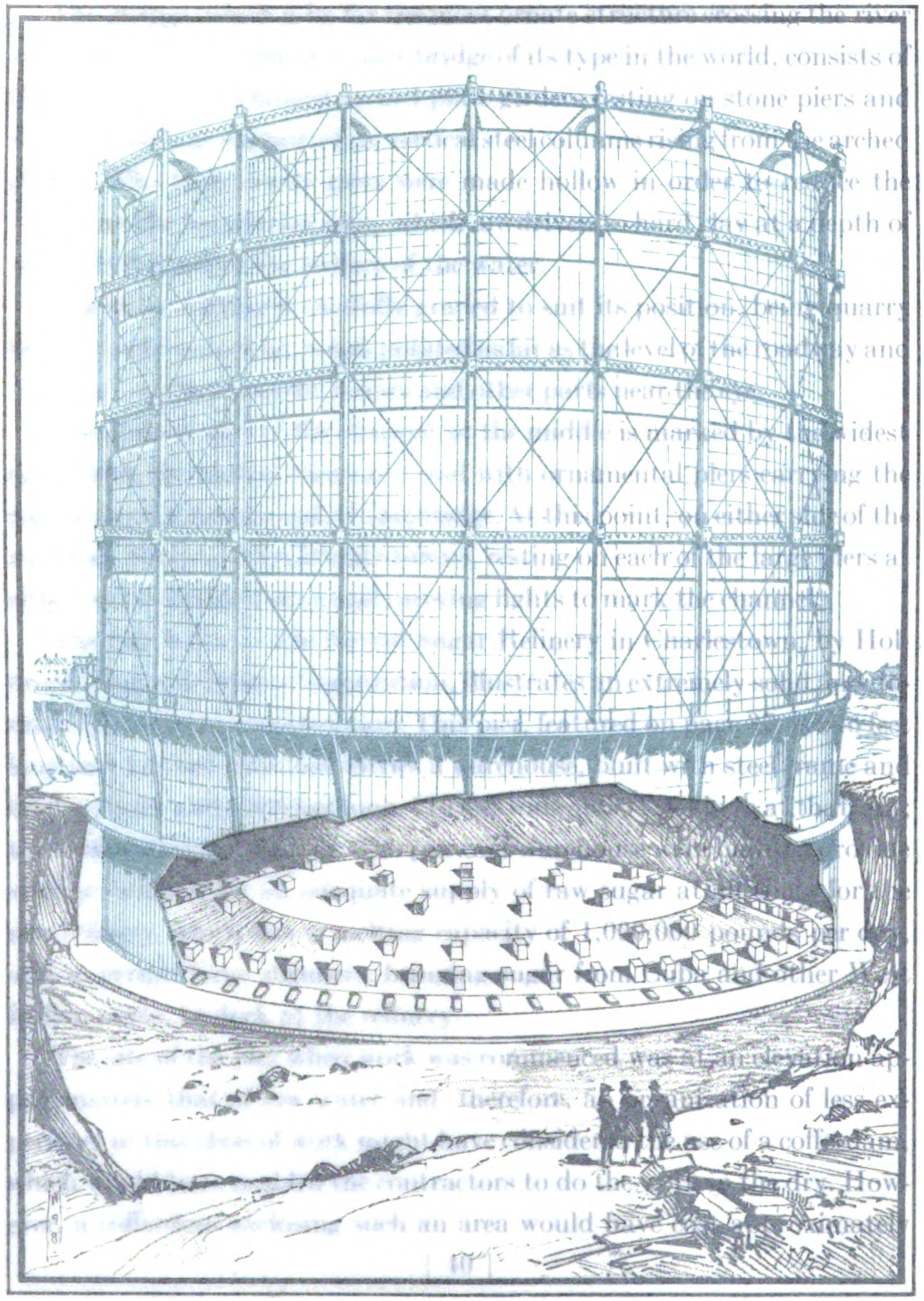
The stone cutting is carefully graded to suit its position, being quarry face up to the water line, rough pointed as far as the level of the roadway and "six-cut" on the parapets, towers and other parts near the eye.

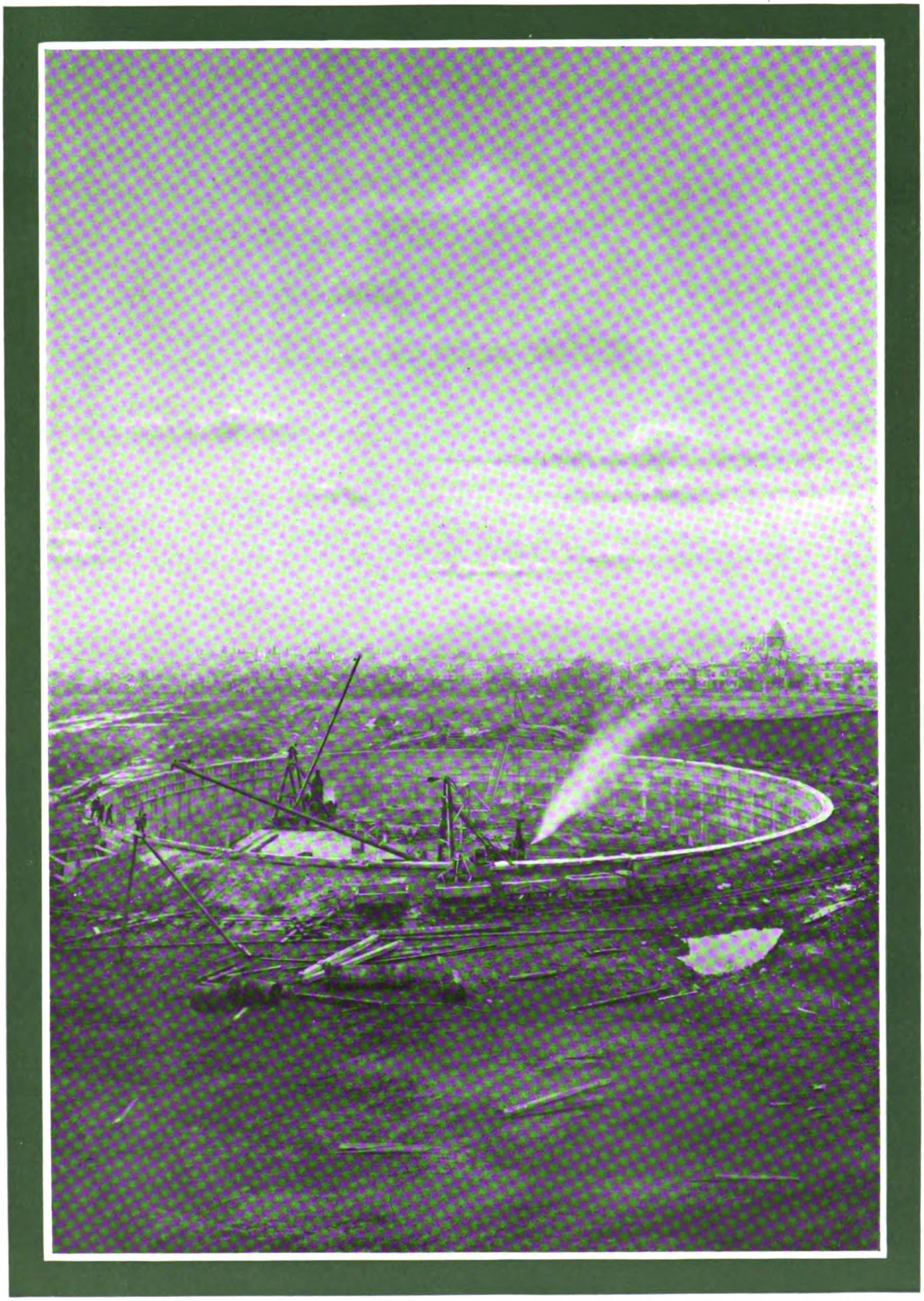
The deepest part of the channel, at the middle is marked by the widest span, with the highest clearance, and with ornamental piers carrying the coat of arms of Boston and of Cambridge. At this point, on either side of the roadway, there are also granite towers, resting on each of the large piers at either end of the long span and carrying lights to mark the channel.

The pier built for the Revere Sugar Refinery in Charlestown, by Holbrook, Cabot & Rollins Corporation, illustrates an extremely solid and durable type of heavy construction. This pier, featured on page 37, is 646 feet long and 124 feet wide and carries a warehouse, built with steel frame and brick curtain walls, 686 feet long, 110 feet wide and 44 feet high at the front; the roof sloping to the rear. The pier and warehouse were built to provide storage facilities for an adequate supply of raw sugar at all times for the new refinery, which has a melting capacity of 1,000,000 pounds per day, and to permit large steamers, bringing sugar from Cuba and other West Indian ports, to dock at the refinery.

The site of the pier when work was commenced was at an elevation approximately that of low water and, therefore, an organization of less experience in this class of work might have considered the use of a cofferdam, which would have enabled the contractors to do the work in the dry. However, a cofferdam enclosing such an area would have cost approximately


WPB





Gasometer—Boston Consolidated Gas Company

$250,000.00, and furthermore, if placed upon such a soft and unstable foundation as the site of the pier offered, there might have been serious trouble when the dam was unwatered.

As steamers were to dock on one side of the pier only, a docking berth was dredged to a depth of 30 feet at low water, and the dock wall, which was of split granite laid without mortar, 18 feet in height, 35 feet and 6 inches wide at the base, and 4 feet wide at the top, was carried on piles which were cut off level with the dredged bottom of the slip. The batter of the wall necessitated the construction of a pile and timber apron in order that cargo steamers might lie at the pier with safety; this apron, which was 14 feet wide, being supported partly on the dock wall and partly on long piles driven just outside the toe of the wall, forming a platform, which also provided room for handling the sugar as it came from the holds of the steamers. This platform, which was a necessity, since the warehouse covered the entire surface of the solid pier, was extended across its outer end.

At the end of the pier, since vessels would be docked only on one side, the masonry wall was stepped up on the bottom from 30 feet at the deep end to 4 feet at the opposite end, and on the back side of the pier the wall went down only 2 feet below low water, or about 4 feet below the level of the flats.

Before actual construction was started a number of test borings were taken covering the site of the work, particularly along the line of the deep wall. These borings indicated that the bottom consisted of silt, sand and soft clay, to a depth varying from 60 feet to 90 feet below low water, and in order to give a proper foundation for the masonry walls it was necessary to drive 6,506 piles to bed rock, the tops of the piles being cut off at 30 feet below low water by means of a specially designed machine. To avoid the expense and trouble of securing piles 90 feet long, which would have been required had the ordinary type of pile driver been used, a special machine was designed which permitted the use of piling of ordinary length and by which

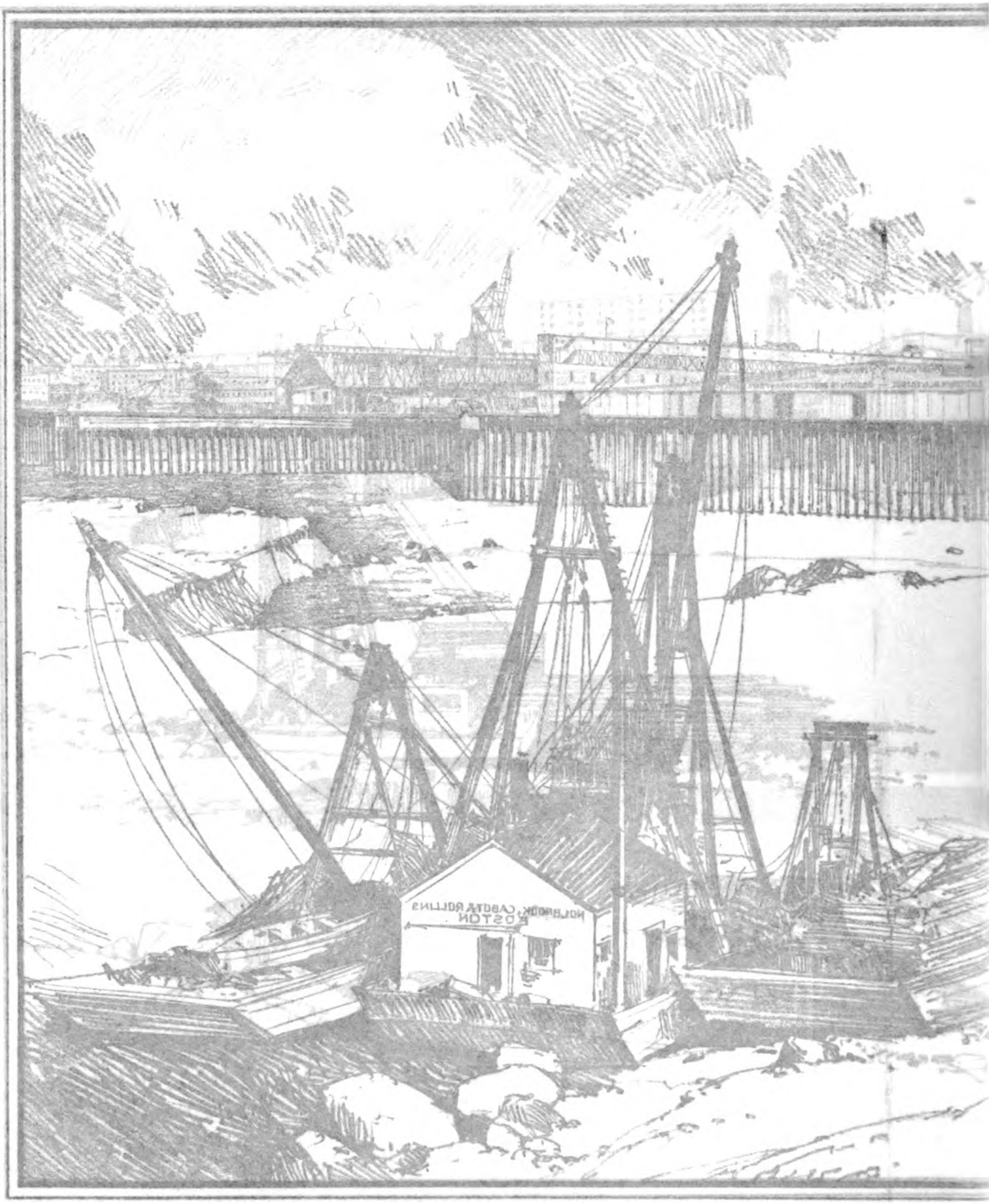
Gasometer—Construction Scene

it was possible to drive the heads of the piles down in 30 or 40 feet of water.

The apparatus used in cutting off the piles, after they had been driven, consisted of a hollow vertical shaft 70 feet long and 5 inches in diameter, supported on bearings and attached to a 12-inch "H" beam fitted with guides to slide in the gins of a pile-driver, where it was suspended by a line running to a drum on the hoisting engine. A system of bevel gears and pulley, driven from a jack shaft connected by a link belt to a specially designed 60 H.P. steam engine, drove a 42-inch circular saw at 400 R.P.M., the saw being keyed to the lower end of the shaft. When in operation, a point was marked on the saw shaft at the height of an engineer's level set at some convenient point on shore. The leveller, by signals to the scow men, kept the saw at a constant level, as the tide rose or fell. By means of lines and steam winches and following the pile sights as guides, the scow was moved over the site of the wall, the piles being cut as it moved.

When the masonry wall, which contained 40,000 tons of split granite,

Hoosac Tunnel Docks


HOLBROOK, CABOT & ROLLINS
BOSTON

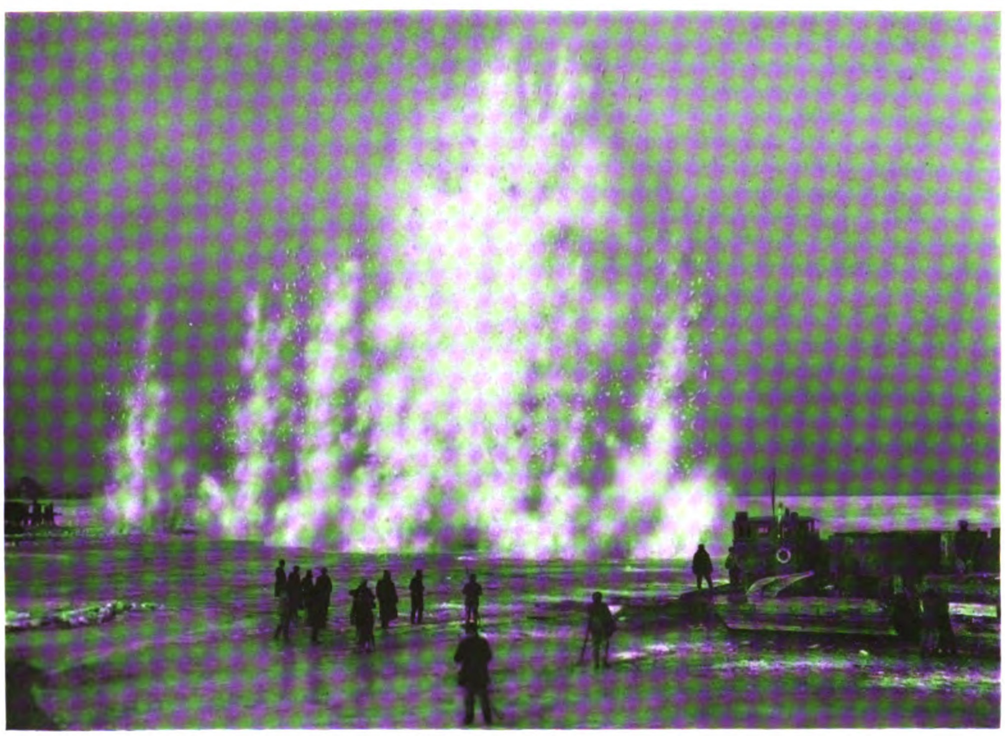
Squantum Destroyer Plant—Construction Scene

was complete around three sides of the pier connecting with the old retaining wall and enclosing the site, the interior was filled solid to the elevation of the floor of the warehouse, the material dredged from the docking slip being used in part, 50,000 cubic yards being required in all, of which 30,000 cubic yards were represented by the dredged material. The total cost of the work, which was completed in 1918, was $500,000.00 and was executed under Mr. H. S. Adams as engineer.

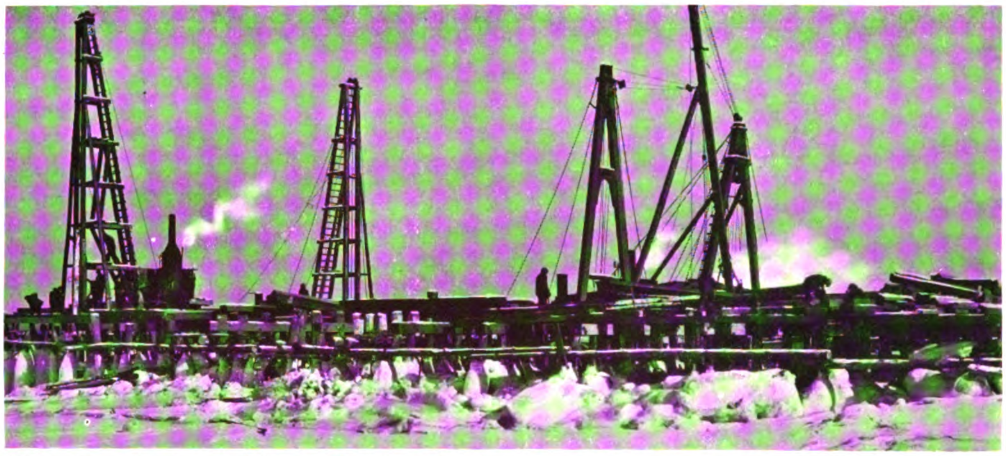
One of the earliest pieces of waterfront work done by Holbrook, Cabot & Rollins Corporation in Boston was the rebuilding of the Hoosac Tunnel Terminals for the Boston and Maine Railroad, shown on pages 44 and 45. This work was undertaken in 1903 to replace piers 40, 41 and 42, which had been destroyed by fire. The wharves, which were built in 30 feet of water, rest on piles extending 15 feet into the bottom, the contract being executed under the supervision of Mr. A. Bissell, chief engineer for the railroad. The docks have capacity for five large ocean steamers, drawing 27 to 35 feet of water, and three smaller vessels, and their freight handling facilities are supported by freight yards having trackage for 850 cars. The piers vary in width from 150 to 350 feet, and the docks are from 30 to 160 feet in width and vary in length from 310 to 630 feet.

On page 41 is a phantom view of one of a number of gasometers built by Holbrook, Cabot & Rollins Corporation for the Boston Consolidated Gas Company. This structure, which is over 200 feet in diameter, required about 100,000 cubic yards of earth excavation; and 8,000 cubic yards of concrete were required for the base. The nature of the work and the method of construction, which presented no unusual obstacles, are evident in the illustrations shown.

"Heavy Construction" knows no barriers of time or weather. A striking example of this is found in the work done by Holbrook, Cabot & Rollins Corporation at the giant destroyer plant built for the United States Government under war conditions at Squantum, Massachusetts.



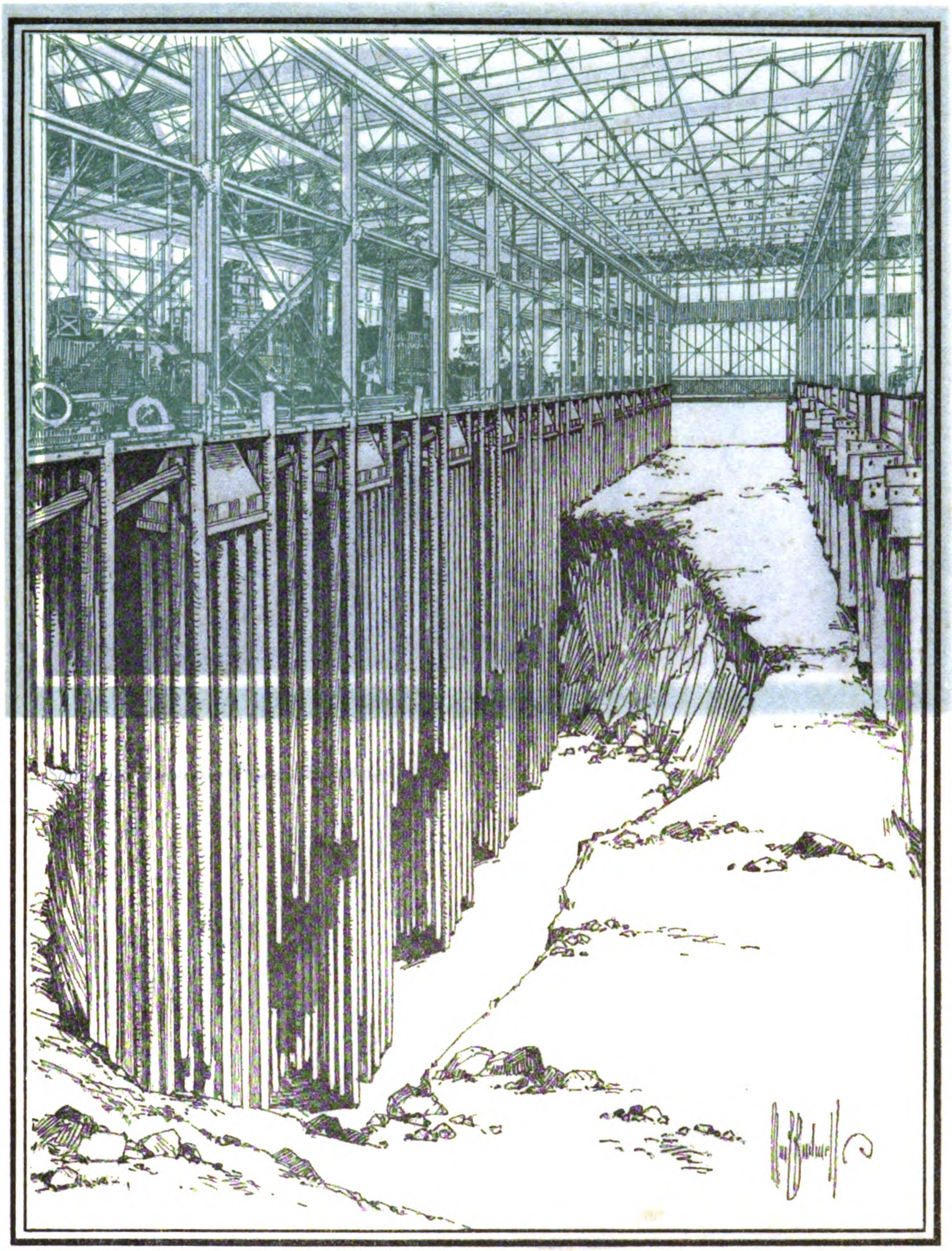
Blasting Ice at Squantum Destroyer Plant

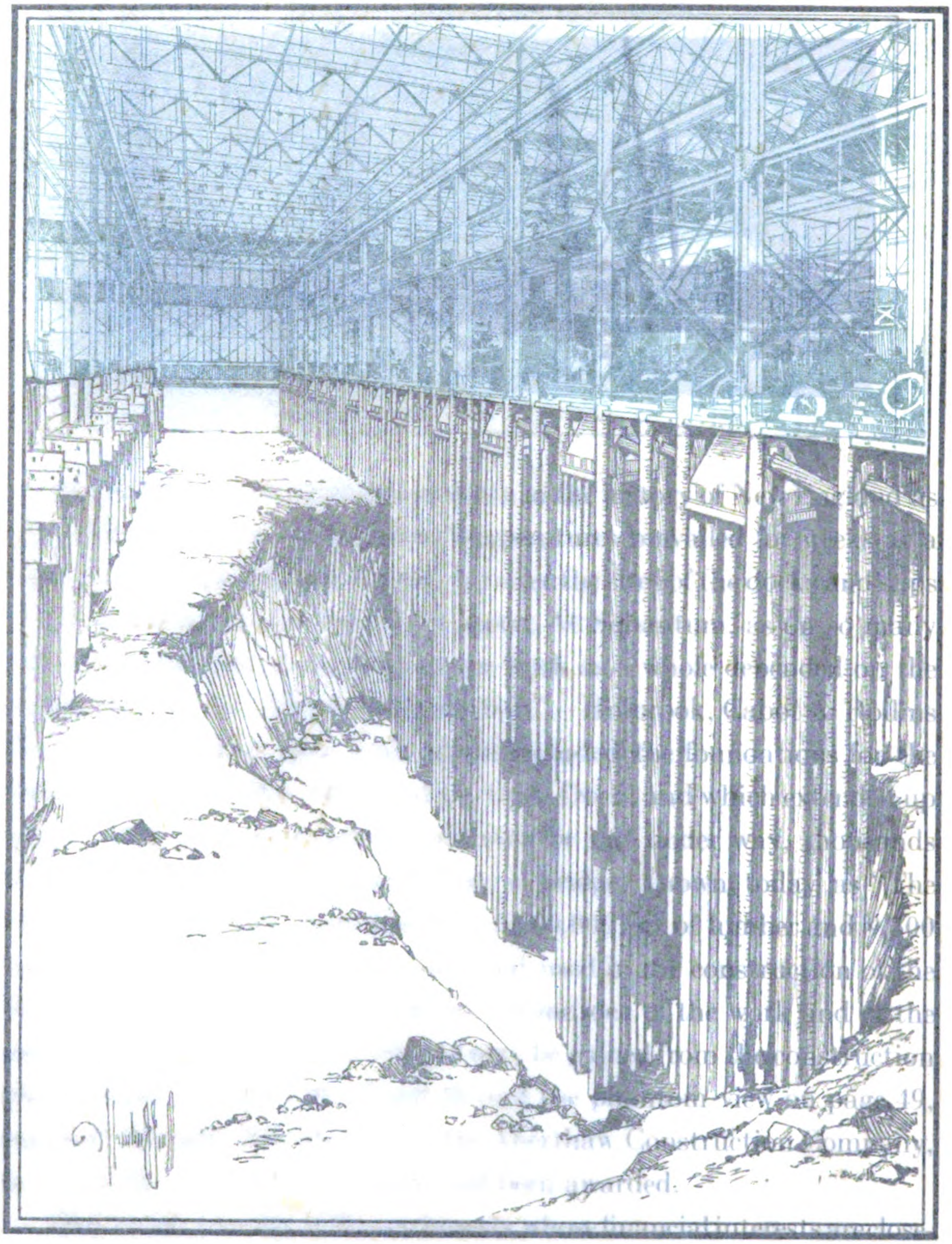


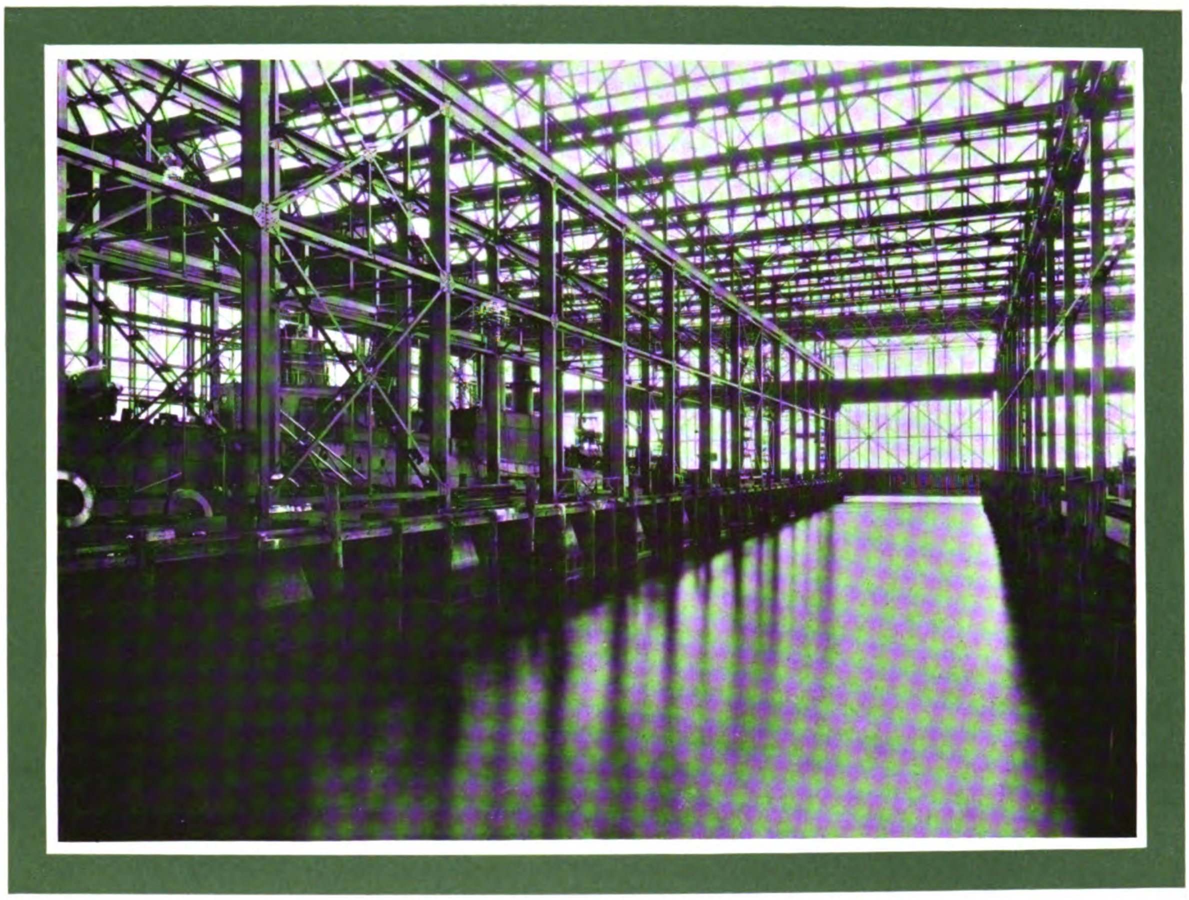
Squantum Destroyer Plant—Construction Scene

The winter of 1917-1918 will go down in the history of New England as one of the coldest on record. Zero temperatures prevailed for weeks at a time. Ice, eight feet thick and more, lay over the sites of the docks and slips —and Washington was calling for speed. At Squantum, as on so many other jobs, the rate of progress on the work as a whole depended on the contractors for the "Heavy Construction"—Holbrook, Cabot & Rollins Corporation. Before their work, which included the foundations for the Building Slips, the Wet Slips, and the Open Dock, and which extended up as far as the high-water level, could even be put under way, thousands of tons of ice had to be blasted out; a bridge, known today as "The Victory Bridge," built; and more than 5,000,000 feet of lumber and 9,500 hardwood piles, exclusive of the material used in the construction of the Victory Bridge, had to be brought in. Some idea of the work and of the conditions under which they labored may be gained from the construction photographs on pages 46, 47 and 48 and the phantom view on page 49, supplied through the courtesy of the Aberthaw Construction Company, to whom the contract as a whole had been awarded.

The Commonwealth of Massachusetts, whose financial interests are closely allied to those of the Port of Boston, is the largest single owner of deep







Squantum Destroyer Plant—Wet Slip

Built 1917-1918

QUANTITIES

Building Slips
2,439 hardwood piles
2,508,887 feet B. M. of lumber

Wet Slips
4,747 hardwood piles
2,044,518 feet B. M. of lumber

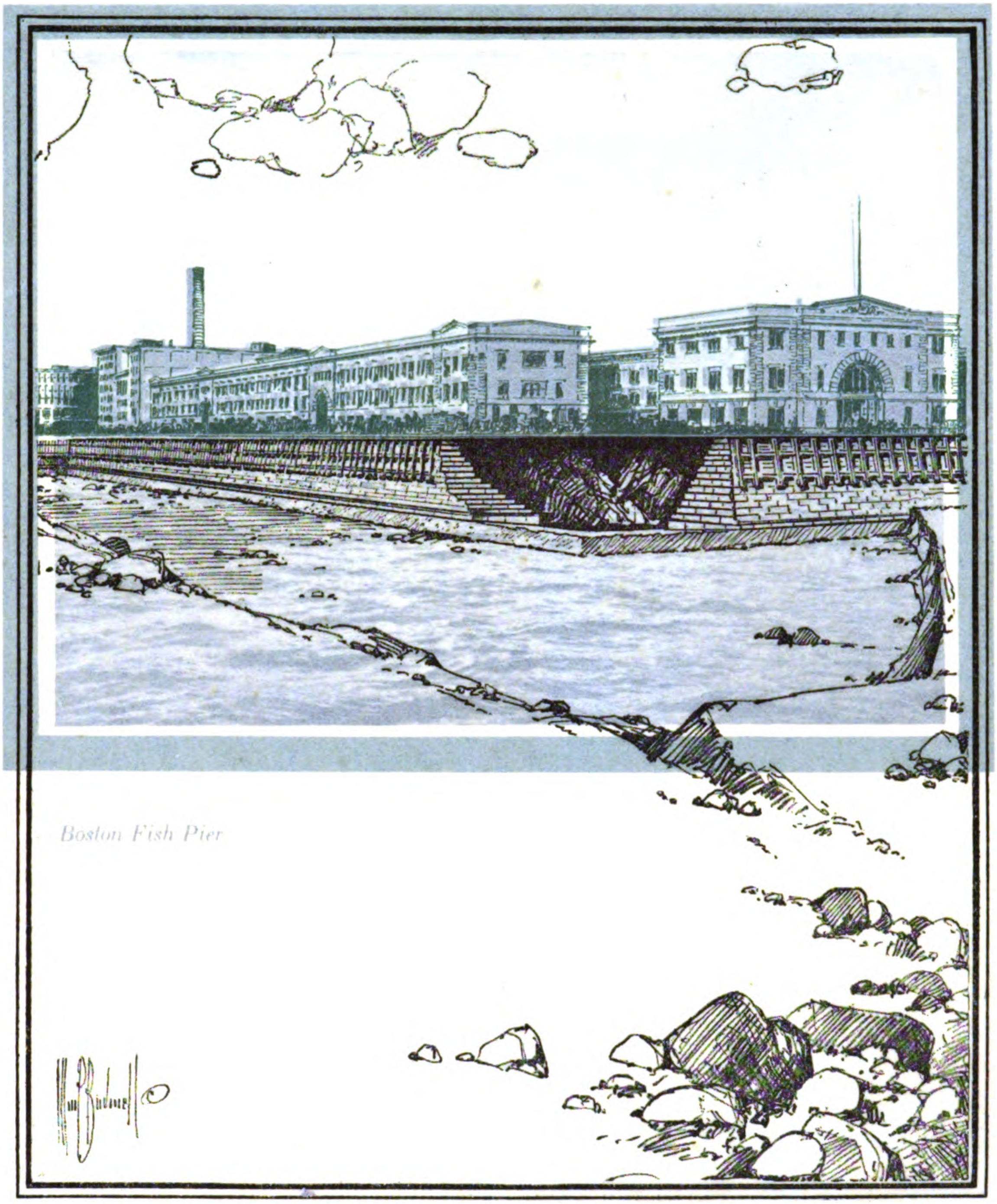
Open Dock
1,350 hardwood piles
688,386 feet B. M. of lumber

water frontage and adjacent territory in the Boston Harbor district. One of the State's greatest holdings is what is known as the Commonwealth's "Flats" in South Boston. In this district two piers, known as Commonwealth No. 5 and the Boston Fish Pier, and a Dry Dock, the largest in the country, have been built. Of these three structures, two, the Boston Fish Pier and the Dry Dock, were built by Holbrook, Cabot & Rollins Corporation.

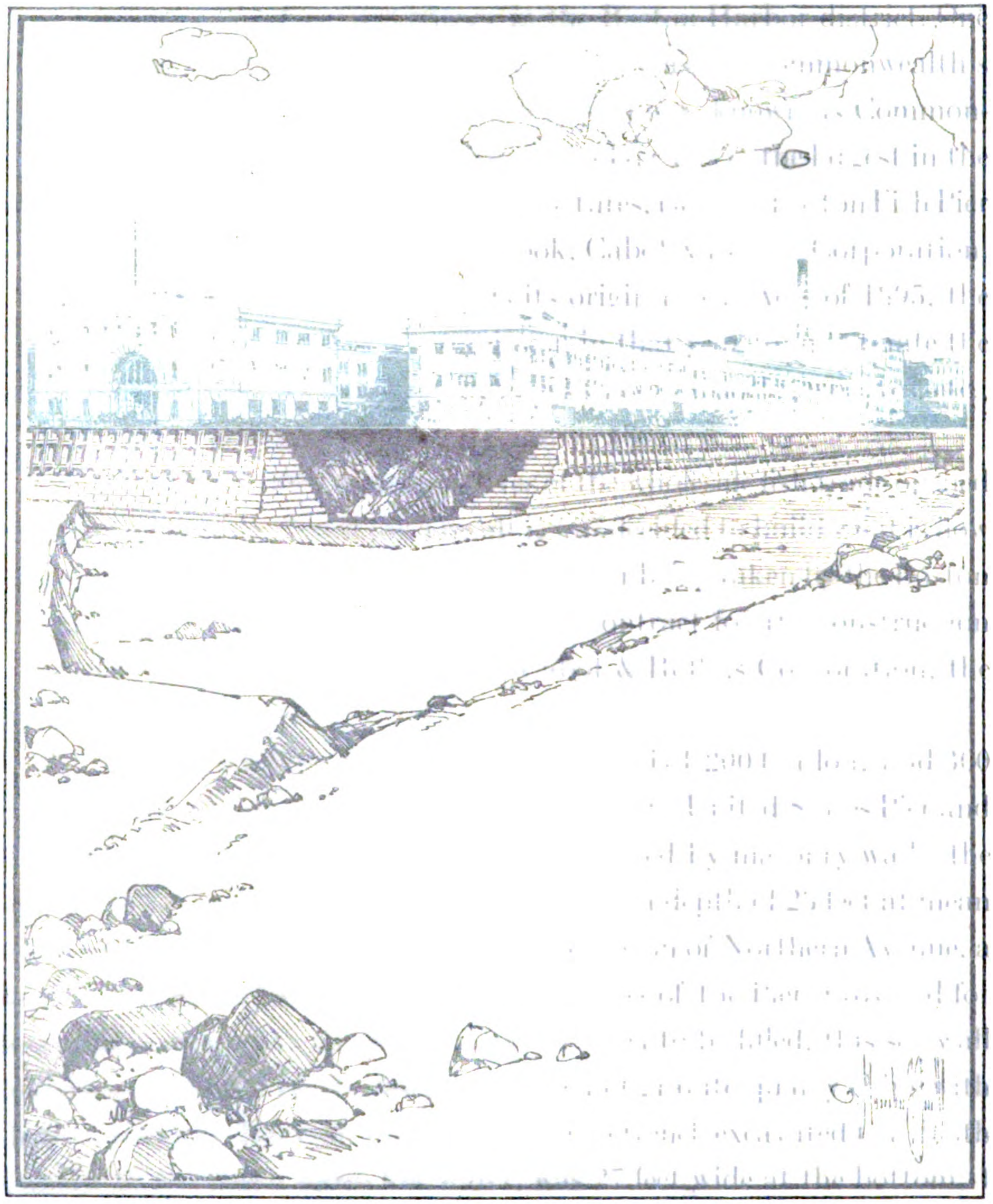
The development of this area finds its origin in the Acts of 1895, the State Legislature appointing a commission in that year to investigate the needs of the Port of Boston for an improved system of docks, wharves, etc., the Commonwealth Pier No. 5 being built in 1897.

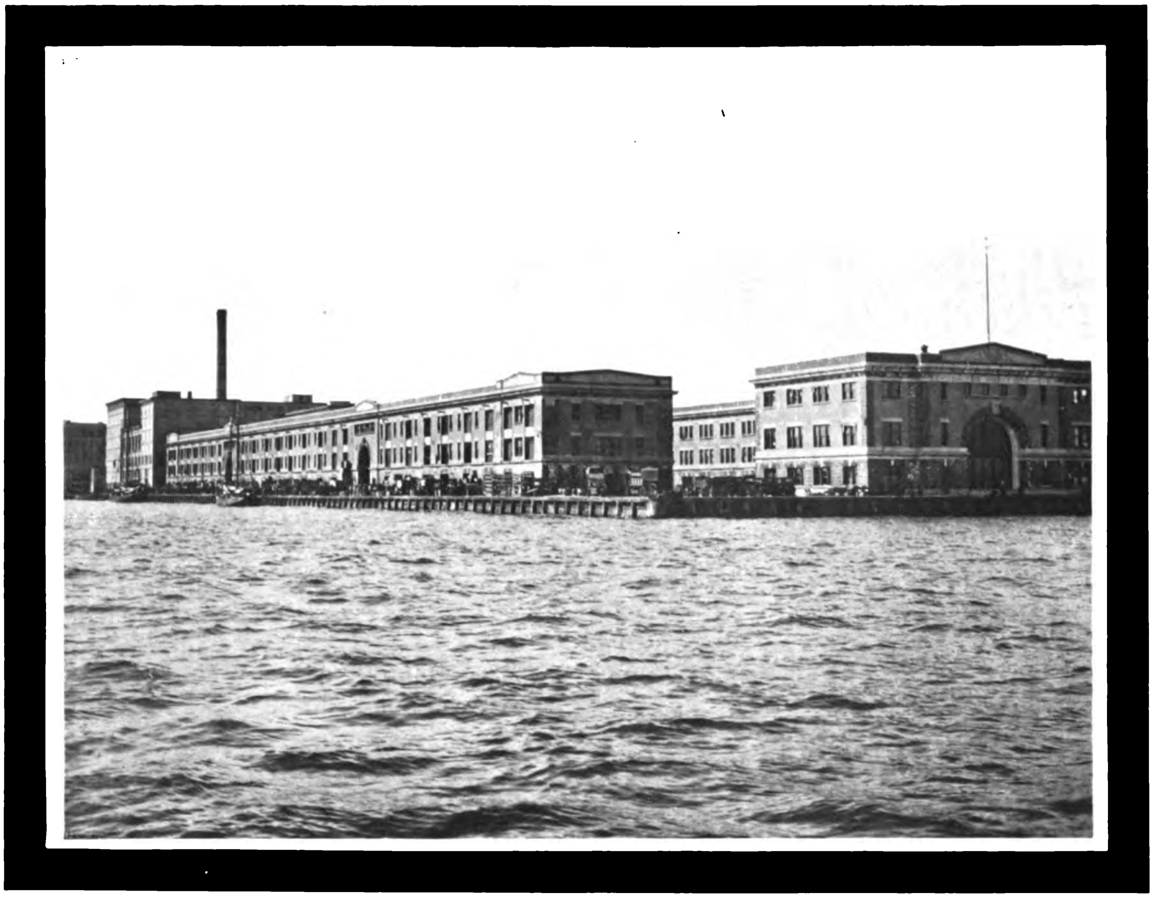
In September of 1909, representatives of the wholesale fish trade opened negotiations with the Board. As a result it was decided to build what is now known as the Boston Fish Pier, a lease of the pier being taken by the Boston Fish Market Corporation. In September a contract for the construction of the Pier was awarded to Holbrook, Cabot & Rollins Corporation, the cost being $760,000.00.

The Boston Fish Pier, illustrated on page 51, is 1,200 feet long and 300 feet wide, and extends from Northern Avenue to the United States Pier and bulkhead line. It consists of earth filling, enclosed by masonry walls, the docks on either side of the pier being dredged to a depth of 23 feet at mean low water. The plans for the Pier and the extension of Northern Avenue, a piece of work essential to the commercial success of the Pier, provided for the building of a heavy sea wall around the area to be filled, this sea wall consisting of granite blocks resting on a bed of granite quarry chips with a ballast backing. The wall, which was laid in a trench excavated to a depth of about 28 feet below mean low water, was 27 feet wide at the bottom, 4 feet wide at the top, and 41 feet high. Its total length was 2,700 feet. The contract also included the construction of a light sea wall, built of granite quarry stone on a pile foundation 645 feet long, on the northeasterly side of Northern Avenue.



Boston Fish Pier





Boston Fish Pier

Completed 1912
Chief Engineer .... MR. FRANK W. HODGDON

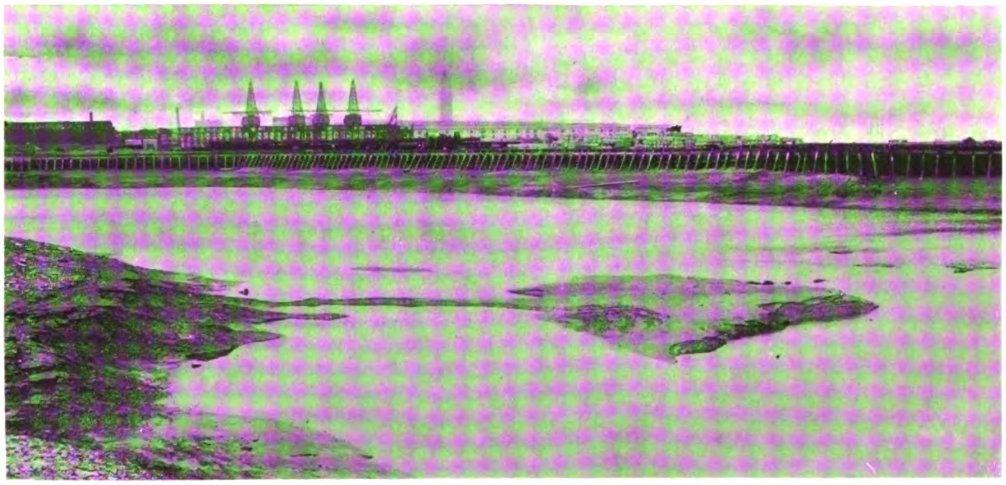
QUANTITIES

62,000 tons of rock rip-rap
112,000 tons of split granite
368,000 cubic yards of fill
414,600 cubic yards of dredged material

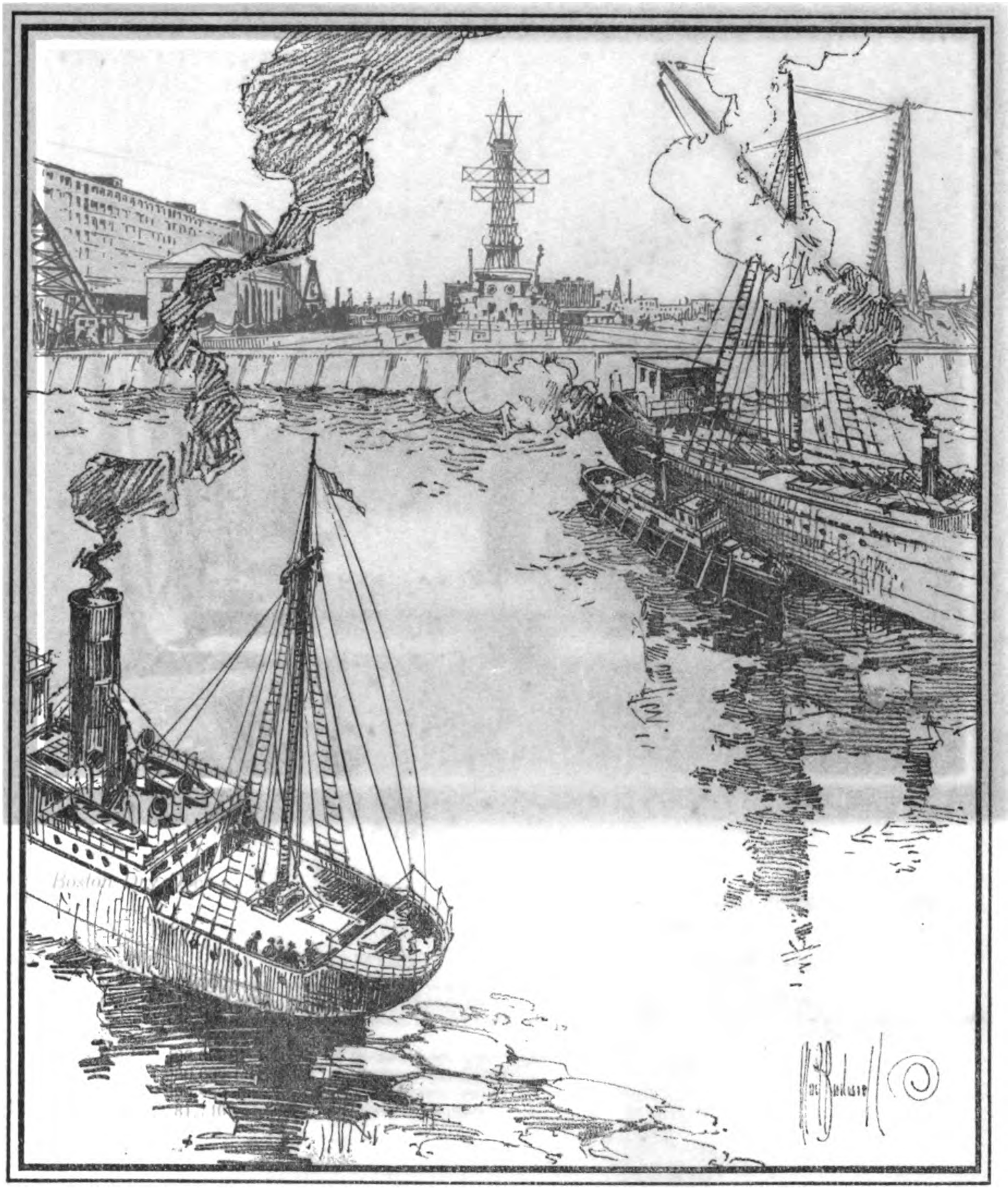
Boston Dry Dock—Construction Scene

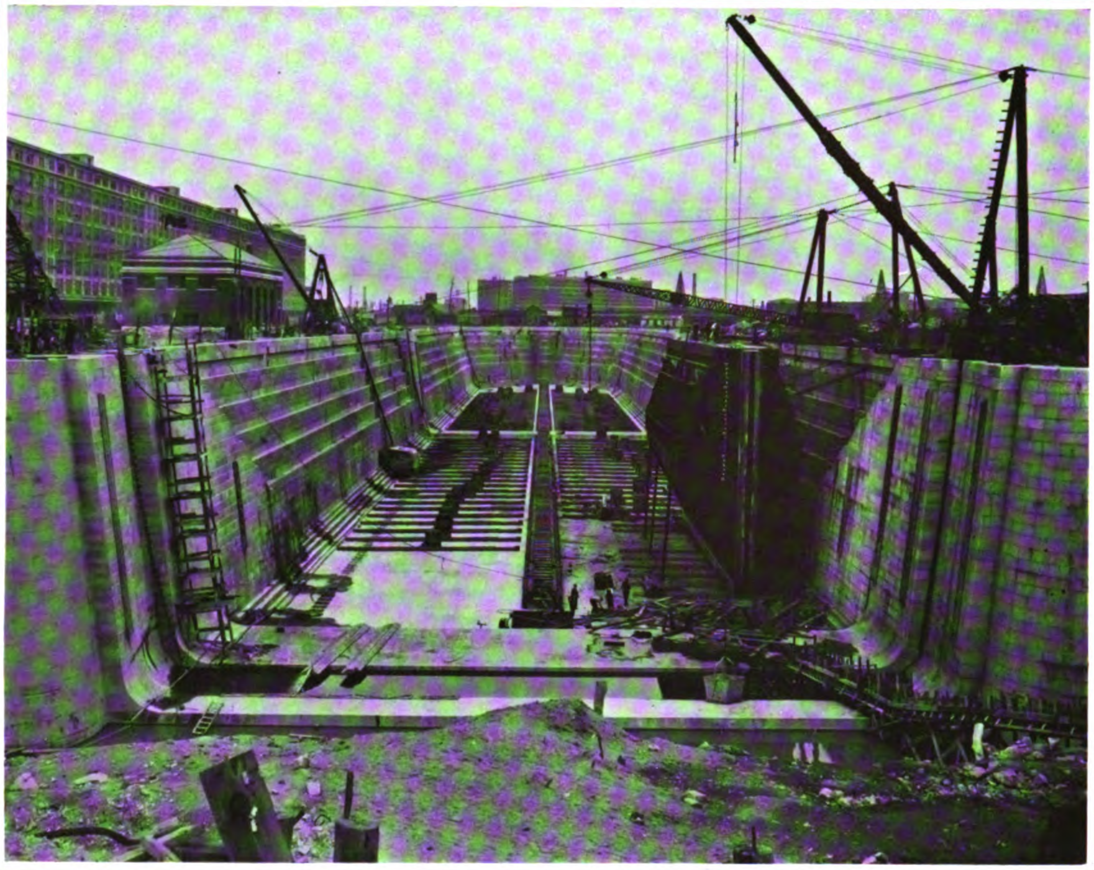
The work—which was actually put under way in 1911— was completed in 1912, during which time 62,000 tons of rock rip-rap were laid in the sea wall enclosing the pier, 112,000 tons of split granite placed, 368,000 cubic yards of filling placed behind the walls, and 414,600 cubic yards of material dredged from the docking slips and fair-ways.

The other unit of the South Boston waterfront development built by Holbrook, Cabot & Rollins Corporation under Mr. Frank C. Hodgdon as Chief Engineer for the Commonwealth, was the Boston Dry Dock, which as a whole represents an outlay of approximately $4,000,000.00. The contract, awarded Holbrook, Cabot & Rollins Corporation on June 22, 1914, was for a stone and concrete dry dock, located on a ledge northeast of the



Site of Boston Dry Dock Before Construction





Boston Dry Dock

Built 1919

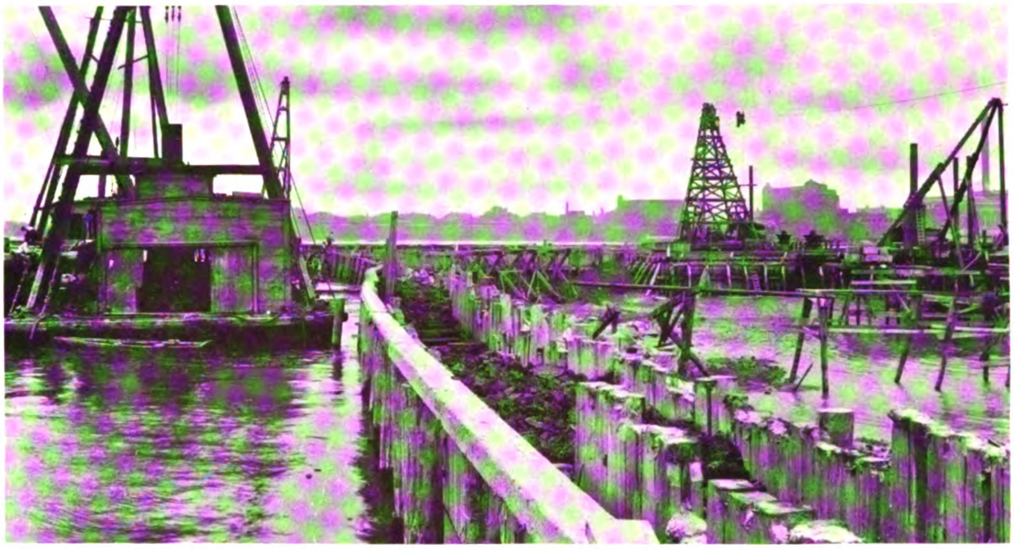
QUANTITIES

119,770 cubic yards of concrete masonry
13,200 cubic yards of granite masonry
1,130,000 pounds of miscellaneous iron and steel
2,300 piles
428,000 feet B. M. of lumber, oak bilge blocks
1,000,000 feet B. M. of lumber, miscellaneous
990,990 cubic yards of earth excavation
81,740 cubic yards of rock excavation

EQUIPMENT USED INCLUDED:

800 ft. Cableway
4 Locomotive Cranes
3 Heavy, Standard-Gauge Locomotives
2 Light Locomotives
20 Twelve-Yard Air Dump-Cars
5 Miles of Standard Gauge Railroad Track, built around the site of the Dock
2 Steam Shovels
4 Travelling Derricks
3 Derricks
12 Hoisting Engines
3 Lighters
2 Pile Drivers
1 Pontoon Lighter
3 Well Drills
12 Steam Drills
10 Pumps
5 Boilers
Electric Motors and Concrete Mixing Equipment

Thirty-three and a half tons, or 67,000 pounds of dynamite were used and 81,740 cubic yards of rock and 990,990 cubic yards of earth were excavated.



Boston Dry Dock—Construction Scene

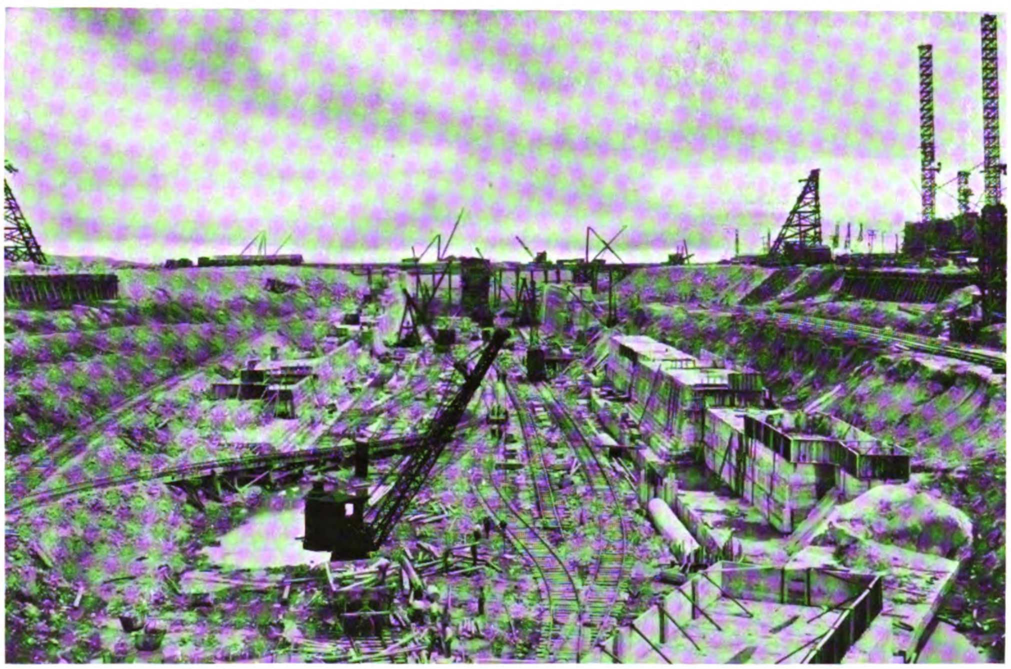
northeast corner of the filled land owned by the Commonwealth. The Dock is 1,200 feet long over all, 120 feet wide at the entrance, and has 35 feet of water over the sill at mean low tide, the contract price for this work being $2,088,000.00. Because of controversies between the Directors of the Port, political interests and other factions, actual work was not begun until October, 1915, and the Dock, a phantom view of which is shown on page 53, was completed in 1919, being accepted by the United States Government on December 22d of that year, when the U. S. S. *Virginia* was docked.

As soon as final authorization for the contract was given Holbrook, Cabot & Rollins Corporation on October 13, 1915, dredging at the site of the Dry Dock was immediately commenced and was continued all winter. In the Spring of 1916 work was begun on the cofferdam, which was about 500 feet long and extended between the bulkheads already built by the State.

The plans for the cofferdam, which the contract provided should be submitted to the engineers for the Port Directors, were for practically the same type as that used in building the Charles River Basin Lock, which had proved most satisfactory under conditions far more severe than those obtaining at the site of the Dry Dock. On the line of the cofferdam the elevation of the Flats was about 6 feet below low water, but a channel, 150 feet wide and 18 feet deep at low water, was dredged from deep water into the Dry Dock excavation, in order to allow the passage of the dredger and scows.

Some difficulty was encountered in the dredging of the hardpan overlying the rock, as the ledge was far higher than appeared on the contract plans, and eventually, dredging inside the cofferdam was given up. The cofferdam was then closed and work begun on the earth fill on both sides of and inside the wall.

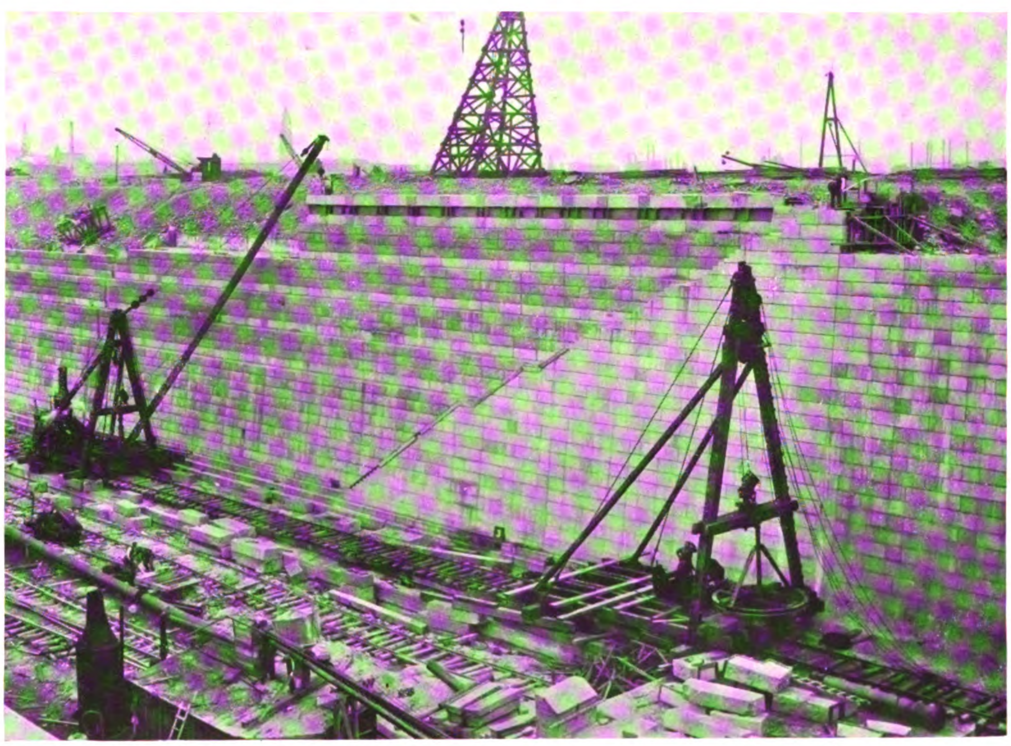
At this point a new difficulty arose. It had been expected that the fill for the cofferdam would be obtained from the Dry Dock excavation—sand gravel, clay—and other material had to be obtained. An attempt was made to use material being dredged by the State in the Mystic River, which seemed suitable for the lower part of the cofferdam fill, but after 10,000



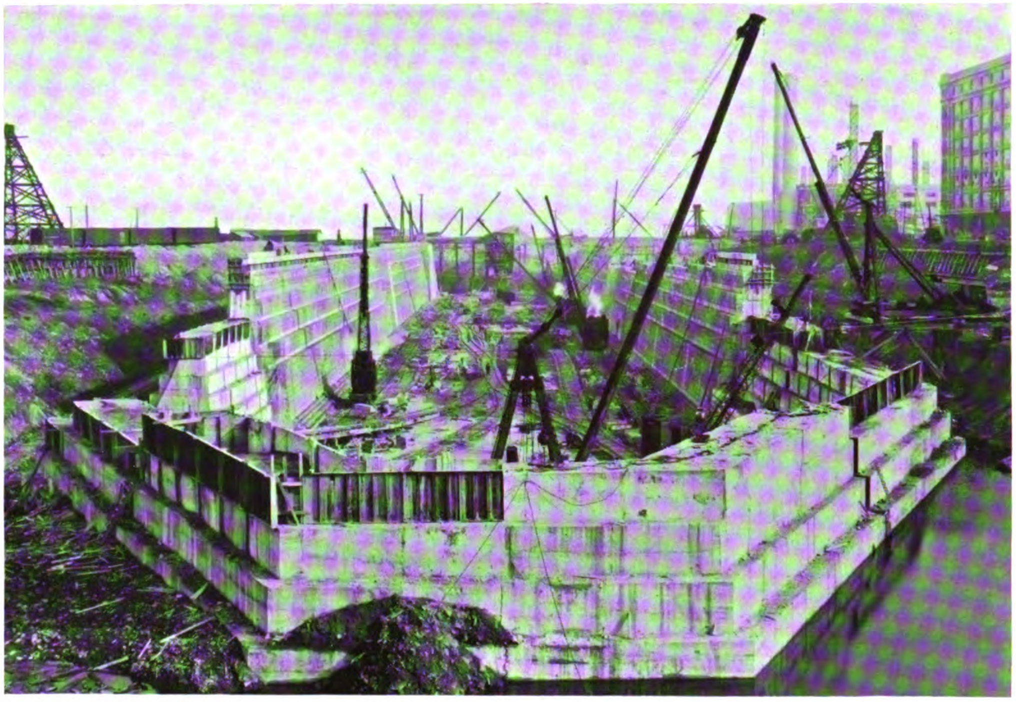
Excavating for Boston Dry Dock

cubic yards of it had been placed, it was found that it would not stand up, and a further search for material for the fill made. Heavy clay, which was being dredged from the fair-way leading to the dock, was tried next, and for a time this seemed to be satisfactory. Trouble soon developed, however, as it was found that the action of the tide reduced it to a very flat slope. The tide gate was then closed and an attempt made to make the fill inside free from tidal action, but although a good bank was built up, it soon slumped and flattened out. A thousand tons of gravel and five thousand tons of stone were bought and placed in one section of the cofferdam, about 75 feet long. The gates of the cofferdam were closed again and pumping commenced. Two direct connected pumps, having a combined capacity on the first lifts of about 12,000 gallons per minute, were used, and on January 1, 1917, the unwatering was complete.

As soon as the dock site was pumped dry, excavation began, two steam



Masonry Work—Boston Dry Dock



Boston Dry Dock—Construction Scene

shovels being employed and spoil removed on railroad trains running into the basin. It was found, after the dredge had finished, that a considerable amount of hardpan remained, overlying the rock. The drilling was carried down through this earth and the rock blasted ahead of the steam shovels.

The placing of the concrete for the Dock proper began on May 31,1917, and the placing of the granite facing for the walls was commenced on September 12 of the same year.

The original design called for a straight dock, but at the suggestion of Admiral F. R. Harris, of the United States Navy, an intermediate sill was added so that, if desired, only the inner end of the Dock need be unwatered, or, by simply building another caisson, the interior section could be used for a vessel docked for a long period and the outer for a vessel docked for a short period. The intermediate sill is of concrete, exactly like the outer, and is faced with granite. As has previously been stated, the whole of the side walls of the Dock are faced with granite. The floor of the Dock is

Boston Dry Dock—Construction Scene

a smooth, granolithic surface, while the sills are of granite throughout. Although in the original design the filling culverts went through the main walls, with the drainage culverts under the floor, it was found more economical, in view of an intermediate sill being added, to have the drainage culverts act also as filling culverts, a method which also afforded better control of the water.

When the Dock was completed in 1919, there had been 119,770 cubic yards of concrete masonry and 13,200 cubic yards of granite masonry put in place, 1,130,000 pounds of miscellaneous iron and steel had been used, and 2,300 piles driven. 428,000 feet B. M. of oak lumber were used for bilge blocks, while over 1,000,000 feet of miscellaneous lumber were used in the construction of the Dock, which requires 50,000,000 gallons of water to fill it and will accommodate any vessel afloat.

As is quite evident from the descriptions given of work performed by Holbrook, Cabot & Rollins Corporation, the contractor of the present day who specializes in "Heavy Construction" is obliged to have not only the technical knowledge of a job which the engineer who designs it possesses, but in addition he must be guided by that greatest of all gifts, "common sense."

The problems of "Heavy Construction" passed to the contractor by the engineer, range from the building of a bridge with foundations 140 feet below water level, often in a swift current and in the midst of navigation, or the construction of a subway, etc., 50 feet below heavy buildings in a crowded thoroughfare, under the surface of which are conduits for the city's light and power systems, steam pipes, sewers, and telephone and telegraph cables, to the building of a viaduct or the driving of a tunnel.

"Heavy Construction" is work that calls for technical skill and knowledge, long experience, great resources, and a personnel composed of men possessed of "nerve" to meet all the troubles which may arise.