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Averaging records for the entire year, it was found that 81.1 per cent. of the water filtered and pumped to the city was recorded by the service meters, while for the month of August 87 per cent. of the water pumped was so recorded. "While this is very gratifying, we hope to account for at least 85 per cent. of the water pumped to the city." The total amount pumped during the year was 2,231,750,000 gallons, of which 621,350,000 was used for domestic purposes and 1,186,350,000 was used for industrial purposes.

The average daily pumpage into the distribution system was 6,120,000 gallons, while the average pumped from Goose creek to the sedimentation basins was 6,410,000 gallons. The difference, or 3 per cent., represents water used for washing filters, dissolving chemicals, making steam, cleaning reservoirs, sedimentation basins and clear water basins and other incidental uses around the plant.

Metering in Augusta

The Superintendent of Canal and Water Works of Augusta, Georgia, J. H. Ferguson, in his report for the year 1921 states that "the report on the operation of the pumping station shows that the meter system has accomplished everything that was expected for it and has proven to be a salvation of the water works system. Comparing the present year's pumpage with the average of the three years prior to the installation of meters, the pumpage shows a decrease of 48 per cent. This reduction represents water that was absolutely wasted and was an economic crime."

The average daily pumpage for 1921 was 5,030,182 gallons, an average daily per capita of 96 gallons. In 1920 the average daily pumpage was 6,459,696 gallons; in 1919 it was 7,841,800 gallons, and in 1918 it was 8,735,630 gallons. This shows a reduction in consumption in these years of 42½ per cent. in spite of an increase in the number of consumers of 1,055 during that time. At present there are 8,848 meters, of which 515 supply industrial consumers.

The saving in the amount of water to be pumped and filtered does not tell the whole story of economy. During 1921 the running time for the two pumps combined was 8,185 hours or 46.7 per cent. of the total time. This means that the pumping has been brought down to within the capacity of one pump, instead of requiring two pumps to be run, one or both of them on part time and at consequently low efficiency.

In order to keep both pumps in condition, the pumps are run alternately, day and night. This is thought by Supt, Ferguson to be preferable to doing all the pumping at night, operating both pumps together, as there is less pressure on the mains and less wear and tear on valves and packing.

Pier Construction, Wells St. Bridge

Large water-tight concrete tail pits for long double-deck bascule span built in cofferdams enclosing multiple deep cyclindrical foundation piers sheeted down by Chicago well process

The long-span two-leaf bascule bridge across the Chicago river at Wells street is the twenty third of the two-leaf bascule type developed by the city engineers. It is a double-deck structure, 268 feet long from center to center of trunnions, carrying two elevated railroad tracks, two street car lines, two roadways between the trusses, which are 41 feet 9 inches apart and 27 feet in average depth, and two cantilever sidewalks outside the trusses at a lower level.

It has a clearance of 16½ feet above water level, permitting small tugs to pass without opening the bridge, and is 231 feet wide between the faces of the substructure masonry on opposite sides of the river, with a navigation clearance reduced to 200 feet by the fenders built outside the masonry. It replaces a swing bridge on the same site that was about 218 feet long over all, including the pivot pier in the center which reduced the channel to two narrow openings instead of the one wide one now afforded. The new bridge was designed and constructed so as to permit traffic to be maintained over the old structure during the erection of the new one.

SUBSTRUCTURE

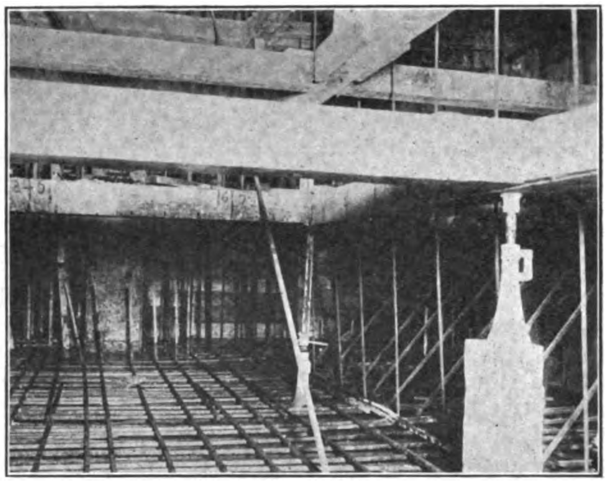
Each bascule leaf is about 172½ feet long, and is pivoted about 27½ feet from its shore end on a horizontal transverse shaft or trunnion, supported on massive girders and columns in the tail pit which permit the revolution of the bascule leaf to a nearly vertical position in which the heavily weighted shore end is revolved to the bottom of the tail pit while the river end rises clear of the navigable channel. The tail pits, resembling massive hollow piers, are about 48 feet square and 30 feet deep inside, with walls having a maximum thickness of 10 feet at the base, a minimum thickness of 5 feet at the top, and a floor 6 feet thick supported at an elevation of 31 feet below water level on six cylindrical concrete piers carried down to an elevation of 75 feet below water level. The walls and floors are made of 1:3:5 concrete with 10 pounds of hydraulic lime for every bag of Portland cement.

COFFERDAMS

The tail pits and their foundations were constructed in the open in U-shape cofferdams about 90 feet wide over all transverse to the bridge axis, with the wings extending back from the 90-foot face to the shore. The cofferdam wall was about 4 feet thick with an inner face of interlocking steel sheet piles 45 feet long and an outer face made with a double line of 3 or 4-inch wooden sheet piles 35 feet long reinforced by round piles 40 feet long, the space between them being filled with puddle.

As the pumping and excavation progressed inside the cofferdam, the walls of the latter were braced by longitudinal and transverse 12 x 12-inch timbers arranged in courses from 4 to 6 feet apart vertically and forming 6 x 12-foot horizontal pockets. The first course was placed at water level, the longitudinal and transverse braces all in the same horizontal plane, one of them being cut to clear the other at intersections and spliced across with wooden scabs. It was supported at intersections by vertical posts which, under the lower course, were replaced by adjustable shores having jack-screws on top that were shifted from time to time to permit the concrete to be placed continuously below them. The total excavation for the bridge amounted to 20,901 yards, of which 2,804 yards was rock and masonry and 2,467 yards was earth excavated from the cylindrical foundation piers. The linear feet of piles required totaled 22,100.

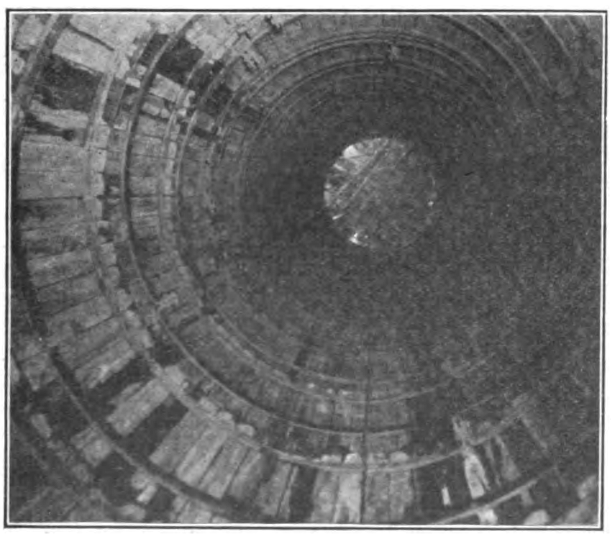
Each tail pit is supported on six concrete cylindrical foundation piers that were at first proposed to be sunk 178 feet below water level to rock bearing, but eventually were seated on hardpan 75 feet below the water surface. These piers are arranged in pairs, one pair supporting the river side of the tail pit, another pair supporting the trunnions, and the third pair supporting the columns. The river piers are 11 feet in diameter enlarged to 19 feet at the bottom; the trunnion piers, 10 feet in diameter enlarged to 18 feet feet at the bottom, and the anchor piers 7 feet in diameter enlarged to 12 feet at the bottom. All are reinforced with horizontal bars at the base and with vertical bars around the circumference of the shaft. Two piers 7 feet in diameter were built to support the abutments beyond the tail pits and two 5 feet in diameter were built outside the tail pits.



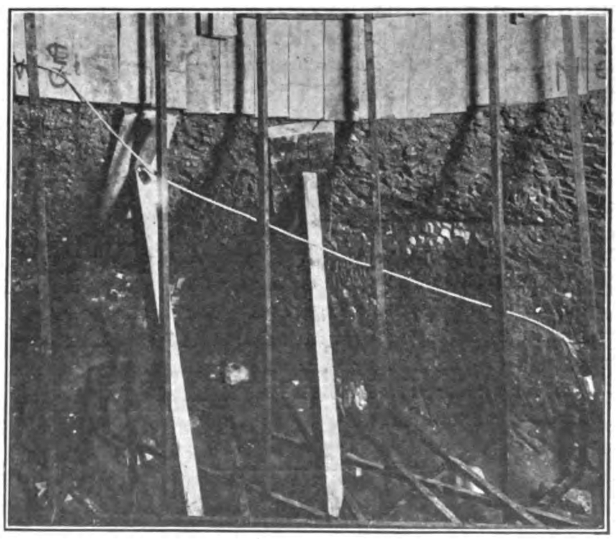
REINFORCEMENT FOR TAIL PIT FLOOR AND WALLS. COFFERDAM BRACING ABOVE SUPPORTED ON JACK SCREWS.

All of the wells for the cylindrical piers were excavated by the standard Chicago well method, the earth side being retained as fast as excavated by vertical 3 x 6-inch tongue and groove wood staves, in 56-inch lengths with the edges beveled on radial lines, each section of the lining was braced with two interior steel rings, each made in sections bolted together through inside flanges, and both lining and rings were left in permanent position when the concrete was placed in the well. The contractor was required to supply six iron extensible trench braces with 2-inch screws and radial segment shoes to support the sides of the shaft in case of emergency.

The wells were filled with 1-3-5 concrete spouted to position and deposited in 4-foot courses, each course being carefully leveled and inspected to insure proper consistency, homeo-



INTERIOR OF 11-FOOT FOUNDATION WELL, SHOWING LAGGING AND REINFORCEMENT IN ENLARGED BOTTOM.



REINFORCEMENT BARS ASSEMBLED IN BOTTOM OF 10-FOOT WELL ENLARGED TO REDUCE MAXIMUM PRESSURE TO 8 TONS PER SQUARE FOOT.

geneity, and the accurate positioning of the reinforcing metal. The specifications provided that if clear water more than 3 inches deep appeared on the surface of the concrete, the concrete should be enriched to proportions of 1:2:3 and placed by hand or by the use of modern dumping buckets.

CONCRETING TAIL PITS

Steel plates, 12 inches wide, driven with vertical angles 3 feet apart were temporarily placecd 6 inches from the inner surface of the wall and shaft forms and the space between them and the forms was filled with 1:2 portland cement mortar placed simultaneously with the concrete to form an outer finish. The steel plates were maintained in position by spacing blocks and were removed as fast as the concrete and mortar were placed.

The bottom of the tail pit floor was heavily reinforced with longitudinal and transverse steel bars with the ends bent up vertically to engage the wall concrete. After these bars had been assembled in position, the vertical shores supporting the interior of the cofferdams were replaced by adjustable struts having jackscrews on top that permitted them to be shifted from place to place as the concrete was deposited, enabling the latter to be applied in a uniform continuous course without vertical holes. As the concreting was carried up, the cofferdam braces were removed to clear it and after the concrete had been placed the sides of the cofferdams were braced against it.

WATERPROOF TESTS

After the completion of the tail pits the tightness of the floors and walls was tested by filling the space between the cofferdam and the tail pit with water up to the river level, producing an unbalanced pressure which did not develop any leaks in the concrete. After the completion of the satisfactory tests the cofferdams were removed and the rubble fill dredged out to the original depth. Each course of concrete in the wall was allowed to set from 12 to 24 hours, all laitance, dirt, etc., was removed from the top of the concrete and it was thoroughly cleaned and flushed with water before the next course was applied.

The work was executed by the Fitzsimmons and Connell Dredge and Dock Co., contractors, of Chicago, under the direction of Charles R. Francis, commissioner of public works; William Burkhardt, deputy commissioner of public works; Alex. Murdoch, city engineer; Charles F. Healy, assistant city engineer; Thomas G. Pihlfeldt, engineer of bridges; Clarence S. Rowe, engineer of bridge construction; and F. A. Berry, engineer in charge.

Freak Stream in Washington

A worthy rival of the famous South American "River of Doubt," which was accused of flowing up-hill, is a stream in southern Washington, according to a correspondent—the company special agent at White Salmon. He sends the following report concerning this amazing watercourse:

A small stream called Bear Creek, flowing from the glaciers of Mount Adams, is a freak. It plays hide-and-seek along its course through the forest, slipping into a cave here, a crevice there, then reappearing below a full-fledged rivulet. Its bed is ice-coated nearly the entire year; on the surface rocks float, in the water logs sink.

The water is bright yellow in one place, red in another, and like bluing where it flows into the Columbia River.

Bear Creek, differing from other streams, freezes at the bottom first instead of at the surface. This is caused by a rocky formation, similar to a corrugated washboard, retarding the movement of the water, forcing the surface to move more swiftly. In this way air-bubbles, carrying freezing temperatures, are shot downward and ice forms. Often in winter the stream flows on the surface while the bottom is solid ice.

This freak creek also contains less water in one part of it than in another as you follow its downstream. A four-foot depth quickly becomes a tiny brooklet by the water disappearing into the porous volcanic bedrock; later it reappears and resumes its course.

The logs that readily sink are a species of blackjack pine with specific gravity heavier than water. They are carried into the creek by landslides.

Rocks seen floating are a sort of pumice, or lava clinkers, released by melting glaciers.

The yellow color is direct from the glaciers; the red is caused by red clay bluffs, and the blue by a deposit of copper quartz through which the stream has cut its bed.—*From "Standard Oil Bulletin."*

Rainfall Intensity Curves

In connection with designing storm sewers for the city of New York, records of rainfall are used which are considered to serve better as a basis for prognosticating the frequency of high intensity rainfalls for the entire city than can be obtained in any other way. These curves are based upon a series of observations covering 52 years, believed to be the longest continuous record in existence.

"The Municipal Engineers of the City of New York" published in 1913 a series of curves showing the intensity of rainfall for different durations and frequencies based upon the records of the Central Park (New York City) self-registering rain gauge from January 1, 1869 up to that time. These curves have been revised by Kenneth Allen, sanitary engineer for the Board of Estimate and Apportionment, to include all the records up to the close of 1920. These revised curves are shown in the accompanying diagram.

It will be noted that these show intensities of rainfall in storms that may be expected to occur once in five years, once in ten years, fifteen years, twenty-five years, fifty years, one