

SUBMERGED GAS MAINS AT NEW HAVEN.

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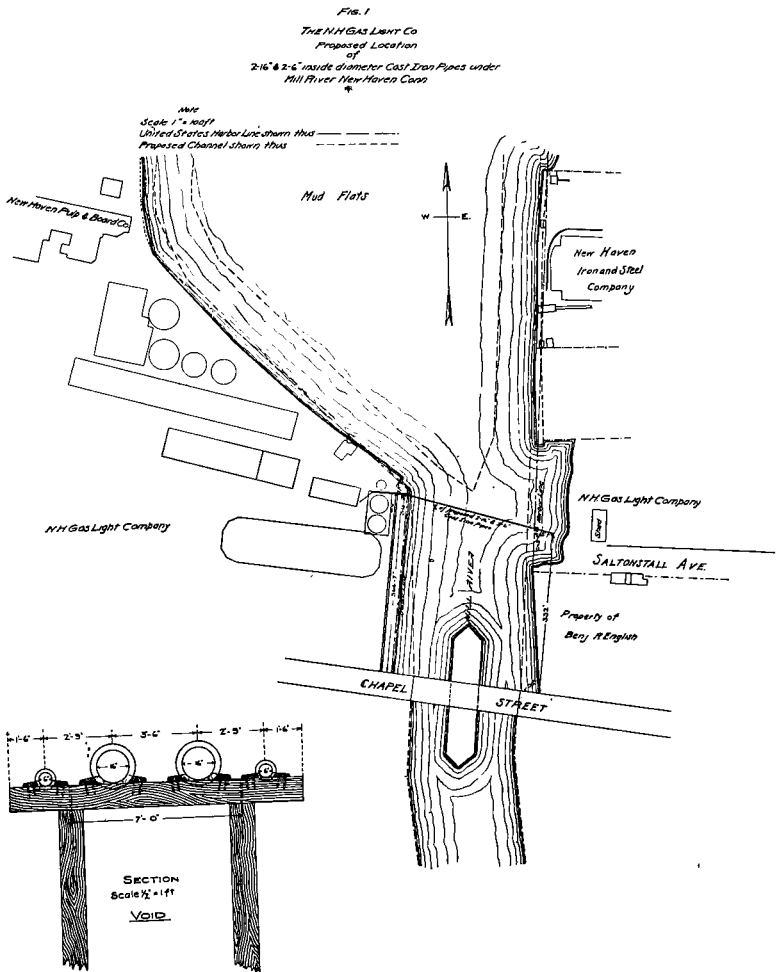
A study of the conditions as they existed in 1909 relative to the supply of gas to the rapidly developing territory, east and south of a point locally known as the Four Corners, showed the necessity of a larger supply at an early date to properly serve the public. To meet this condition it was decided to run a reinforcing main from the New Haven Gas Light Company's Manufacturing Plant located on the west side of Mill River, north of Chapel Street, in the City of New Haven, to East Haven and Morris Cove. The most direct route involved laying a pipe under Mill River and Quinnipiac River.

During the construction of this work and since its completion several requests have been received asking for a description of this interesting piece of work. To those closely connected with the work it was decidedly interesting in more ways than one.

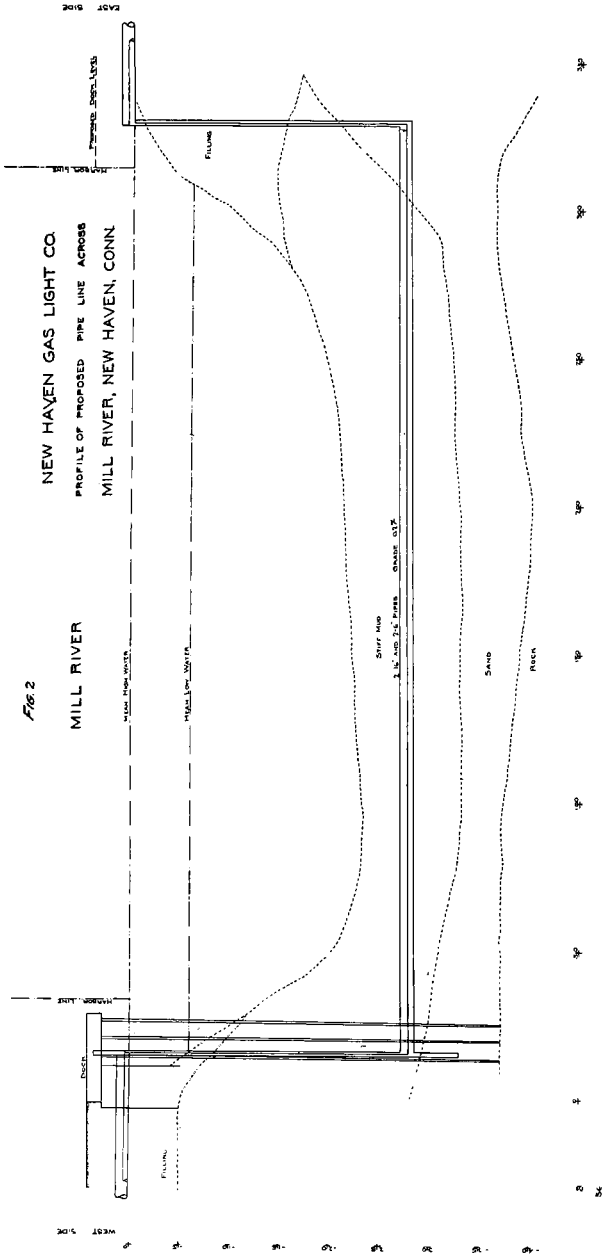
We were somewhat handicapped by not having any previous experience in this kind of work. Mr. A. B. Hill was called in as consulting engineer, and assisted in the preliminary studies. The contract was awarded and work carried on under his direct supervision. There were numerous obstacles to be overcome and some of our troubles are noted in this description. This plan is followed so that others contemplating a similar piece of work may have some idea of what possibly awaits them.

From our preliminary studies we concluded we would make no allowance for contraction and expansion on the horizontal line of pipe in either river. The length of line in Mill River would be approximately 325 feet and in Quinnipiac River 700 feet. While no tests were made, it is doubtful if the change in temperature of the mud in the bottom of the river would vary more than 15° Fahrenheit per year. This would cause a variation of approximately $\frac{3}{8}$ in. in Mill River and $\frac{3}{4}$ in. in Quinnipiac River. As the ends of the horizontal pipe would be free to move, we saw no reason for installing a flexible joint. At the point of crossing, the west bank of Mill River has been formed

by filling in on top of mud flats. The depth of this fill and mud varies from thirty to forty feet before solid bottom is reached. It was necessary to lay the gas main on piles on this approach.



After taking that precaution we had no assurance that the bank would not move, and if there was even a slight movement, it probably would cause a broken pipe, consequently a flexible or ball joint was proposed on the vertical portion of the submerged pipe. The very important question as to whether flanged pipe

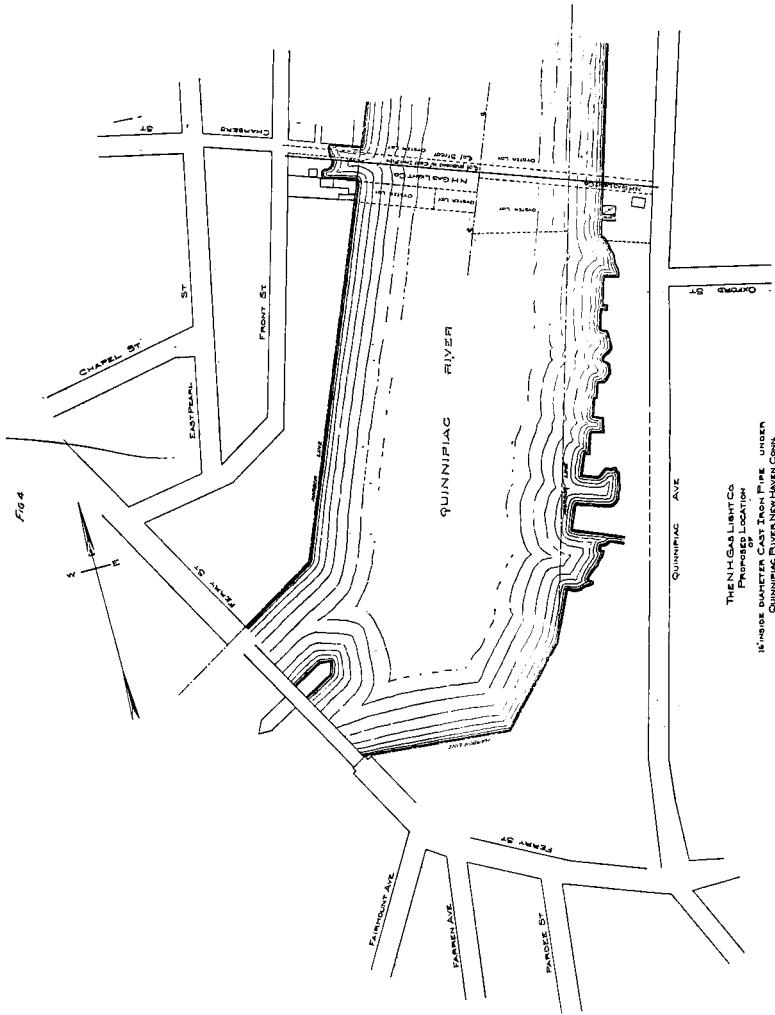


or bell and spigot pipe would be used, and the details of the method of joining the pipes together, was then taken up. This was considered carefully and it was decided to use bell and spigot pipe, to make up a section on land consisting of several lengths of pipe, using cast lead for joints, and to make the bell and spigot joint, joining the several sections under water, of lead pipe. Having settled these questions, we were ready to prepare specifications for the work: 16" diameter was the size of pipe decided upon. As serious results might follow if an accident should happen to a pipe while in use, it was decided to lay two pipes 16 in. in diameter, and to join them at each side of the river, placing gates on each line and holding one line for emergency. As the New Haven Gas Light Company owned a fair sized parcel of land on the east side of Mill River where a landing was to be made, and not knowing to what use this piece of land might be put at some future time, the precaution was taken to lay two pipes six inches in diameter on the same foundation with the 16 in. gas mains, thus connecting the properties on each side of the river by these pipe lines. Soundings were taken over the proposed line of pipe, also borings were made approximately fifty feet apart to determine the character of the river bed. Figure 2 shows the result of these borings in Mill River. At this point the river has a channel approximately sixteen feet in depth between harbor lines. The bottom is formed by a layer of mud ten feet in depth, which rests on top of a layer of sand five feet in depth. Rock underlies the bed of sand. The United States Government required the top of our main to be twenty feet below mean low water. A contract was let to lay two 16 in. diameter pipes and two 6 in. diameter pipes on a pile and timber foundation; the piles to be sawed off to a given grade and capped by 8 in. x 10 in. timbers. The stand pipes at the east and west sides of the river were to be protected by cribs. The work of dredging Mill River between harbor lines was readily accomplished. While the sides of the trench slid some, there was not as much sliding or caving as was expected. There was no unusual incident connected with driving the piles and capping the same. This was done during the season of 1910. Unfortunately the pipes were not laid until the Spring of 1911, and by this time there were four feet of soft ooze on top of the caps. By way of explanation; the reason

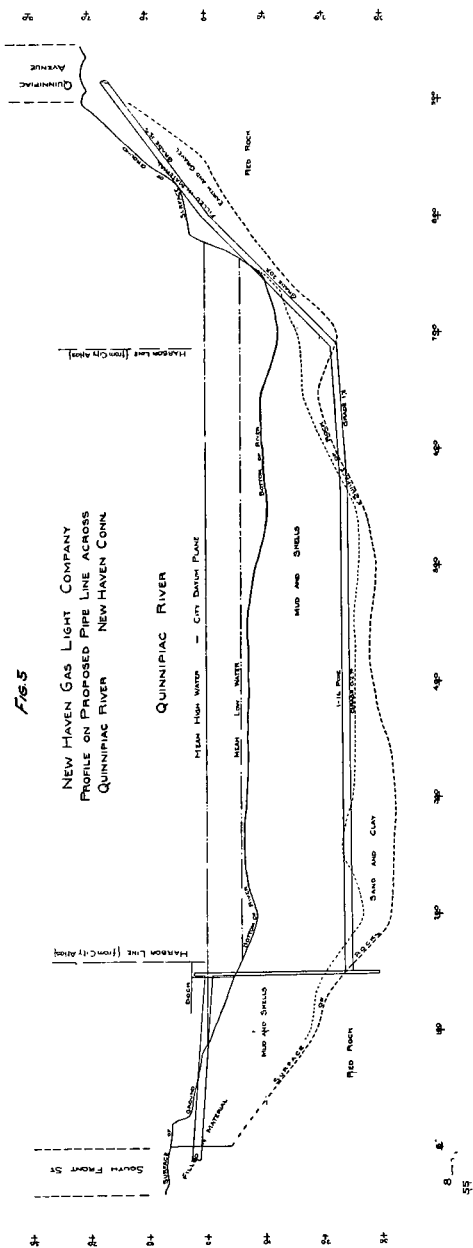
the pipes were not laid was that the contractor was engaged on the work at Quinnipiac River. The profile does not show any rock to interfere with building the crib and placing the drip on the west side of Mill River. However, we found a projection that did interfere with building the north end of the crib. The crib was built and securely fastened to an anchor by means of three rods two inches in diameter. This anchor was not constructed for the purpose for which it is now used. It originally was a pile and concrete foundation for a tank thirty feet in diameter. The concrete was removed sufficiently to allow a 10 in. x 10 in. timber twenty feet long, a lateral bearing against a number of piles. The three two-inch rods, which were made in two pieces connected by a turn buckle, were run through this timber and the crib, and hold the latter from sliding. The rods were wrapped with three layers of burlap soaked in coal tar pitch. The entire area of the foundation was re-concreted. The drip and stand pipe, consisting of two lengths of 16 in. pipe and one 16 in. pipe out of the horizontal opening of the drip, were made up in one piece and lowered to position. Six lengths of 16 in. diameter pipe were lined up on shore and the joints cast and calked. This 72 foot section was handled by suspending it from a girder built especially for this work. The girder was composed of two trusses sixty feet long by six feet deep and spaced one foot apart. There were six panel points or points of suspension. Each point or suspension consisted of a plate on each truss placed opposite each other with a hole in it large enough to take 2 in. diameter pin. This made a very easy and convenient method to attach the chains to hold the pipe. The sections of pipe were lowered into position and held until divers had secured a uniform bearing on each pile cap by means of wooden wedges. The distance between stand pipes was 320 feet; the line was laid in five sections. The sections were all lowered in the same manner. A lead pipe $\frac{1}{4}$ in. inside diameter and $\frac{1}{2}$ in. outside diameter was coiled on the spigot end of the section, being lowered from twelve to fifteen turns. When the section of pipe was lined up and had a uniform bearing on the pile caps, divers proceeded to force the lead pipe in the bell and calk each turn as it was entered. This insured a joint calked from the back of the bell to the face of the bell. This kind of joint was decided upon after several tests were made

by making up joints of different kinds on land, using a split bell that was held in position by bolts. After the joint was made the bell was removed and a section was cut out to be inspected. One of the reasons for using this joint was its simplicity. A diver working in the bottom of Mill River has to be guided entirely by feeling, and the less delicate the task to be performed, the better the work will be done. After several of these joints had been made, the divers expressed some doubt as to the joints being able to stand the required pressure. This made us somewhat uneasy and we had the divers make up three 16 in. joints on land, using the same tools and materials they used under water. Pneumatic tools were used. The joints were then cut open, and examined. While an absolutely perfect bond had not been attained between each of the several turns of lead pipe, the joints were very good. The $\frac{1}{4}$ in. opening in the lead pipe seemed to be the weak point. There was not stock enough to prevent a chewing up of lead when the pneumatic calking tools were used. To overcome this we substituted a lead strip $\frac{1}{2}$ in. x $\frac{1}{2}$ in. for the lead pipe. This worked better. After the line was laid it was flushed by pumping water into the easterly end and removing it from the westerly end. Pumps with 6 inch discharge were used for this work. The line was tested to 50 pounds of air pressure. This air pressure showed that there were small leaks at almost every joint that was made under water. The word "small" is used advisedly, for the water that accumulated in the drips in 24 hours amounted to only a few gallons. The joints were recalked, stood the test, and one 16 inch line put into use at once, and has been in use since May 30th, 1911. The horizontal pipes out of the top of the stand pipe were connected to the land pipes by means of two Dresser insulating couplings. This is to protect us from electrolysis and also acts as a slip joint and will allow for some slight movement of the pipes without causing damage.

We now take up the case of Quinnipiac River. It was necessary to secure a tract of land on each side of the river. This was done by the purchase of a lot 50 feet wide on the west side and a strip of land 30 feet wide on the east side. Thirty feet is not as wide as might be desired but was the only available strip to be bought. There are oyster beds in Quinnipiac River which the owners prize very highly, and the subject of damages to oyster beds is one to be settled in advance of any contemplated



work. The thirty foot strip of land we bought did not allow a dredge to have a dumping scow alongside without resting, at low tide, on the oyster beds not belonging to the New Haven Gas Light Company. Only one line of 16 in. pipe was laid at this river. Figure 5 shows profile of Quinnipiac River. By observing the profile you can see there is very little water at low tide. The United States Government required a depth of 16 feet at mean low water, and this necessitated removing a quantity of rock. The intention was to use pile and timber foundation for supporting the pipe, except where rock interfered. Two bents of piles were driven near the west shore. There were about five feet of mud and sand to hold them in position. Two of the piles floated as soon as the hammer was removed and the other two floated after a few hours time. This idea had to be given up. The mud and sand were washed away down to rock, and concrete piers built on the rock; the concrete being deposited in gunny sacks, filled about two-thirds full to permit the separate sacks of material packing together. The gas main was laid in Quinnipiac River before it was laid in Mill River. A flexible joint was installed in the stand pipe on the west side. On the first test of this line when the gauge showed between 20 pounds and 22 pounds pressure, there was a series of air bubbles around the stand pipe. These bubbles soon reached the proportions of a boiling cauldron. It looked as if something serious had happened under water. The test was stopped and next morning arrangements were made to pump out the pipe. To our surprise, while sixteen hours had passed only forty gallons of water was in the drip. A diver recalced the joints on the stand pipe and the second test started. The same result was experienced as on the first test. Suspicion rested on the flexible joint, rough calculations were made, and it was found that 22 pounds per square inch pressure on the 16 inch flange cover of the tee on top of the stand pipe just about equaled the weight of the stand pipe, and when the internal pressure slightly exceeded the weight of the stand pipe there was sufficient play in the flexible joint to cause a leak. To prove this assumption, a weight of one thousand pounds was placed on top of the stand pipe and the third test started. The area of a 16 inch circle is roughly 200 sq. in. and an increase of five pounds per sq. in. would equal 1000 pounds. When 27 pounds per sq. in. was reached,



the same result was noticed. The air pressure was taken off, and an additional weight of 1000 pounds placed on the stand pipe; the fourth test was started. When the gauge showed 32 pounds, the same result took place. We were satisfied that the trouble was in this flexible joint, and the line would be safer and more useful if the joint was removed. The joint was removed at considerable expense. Clamps at the top and bottom held together by rods prevent any vertical motion of the stand pipe. While an insulating coupling acts as an expansion joint connecting the land pipe with the submerged pipe. Tests on this line were about the same as at Mill River. The joints made under water leaked a small amount at first, but were easily recalked and made tight, and have not given us any trouble since the line has been in use. About seventy-five gallons of condensation are removed from the drip every month, but this is not river water.

A close estimate for the total cost of the work is \$30,000. The T. A. Scott Company of New London, Conn., were the contractors.