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OF THE

# National District Heating Association

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A number of requests were received from member companies on experience with large slip-type expansion joints, and also with pressure regulation of service connections. These two topics were studied by means of questionnaires.

The value of these sessions depends greatly upon the discussion which results from the reading of prepared papers, and which adds to and rounds out the author's presentation. It is hoped, therefore, that members will make notes as the meeting proceeds and will feel free to comment and add their own experience or knowledge of the subject in hand.

I will now call on John C. Haroldson to present his prepared paper. Mr. Haroldson.

. . . Mr. Haroldson then presented his paper . . .

## EIGHT-INCH HIGH-PRESSURE, CONCRETE-ENCASED STEAM MAIN OF THE DULUTH STEAM CORPORATION

**John C. Haroldson**

(In this paper the author describes the 8 in., 150 psi steam line installed in Duluth in 1949.)

This 5 block long steam main was installed during 1949 in downtown Duluth.

It consists of 2,344 ft of 8 in. extra heavy pipe covered with 3 in. of Foamglas insulation encased in a 4 in. concrete envelope. There is one manhole. It carries steam at 150 psi. From end to end it has 16 corrugated, packless type expansion joints. It runs under a sidewalk for one block, under a black top roadway with concrete base for one block, and in the grass plot between the roadway and the sidewalk for the remainder of the distance. There are a total of seven street crossings.

In digging the 2 ft wide trench to an average depth of 4 ft, the usual number of obstructions were encountered, such as storm sewers, water and gas service boxes, trolley poles, and three large trees that had to be removed. The excavation for three of the five blocks was normal, but rock was encountered in the other two. In one it was a medium sized rock backfill and in the other a rock ledge which was found 2½ to 3 ft below the surface.

Fig. 1 shows a cross section of the main. This type of construction was decided upon because it provides a permanent installation, free from floods and corrosive conditions, plus a well insulated line at a minimum cost.

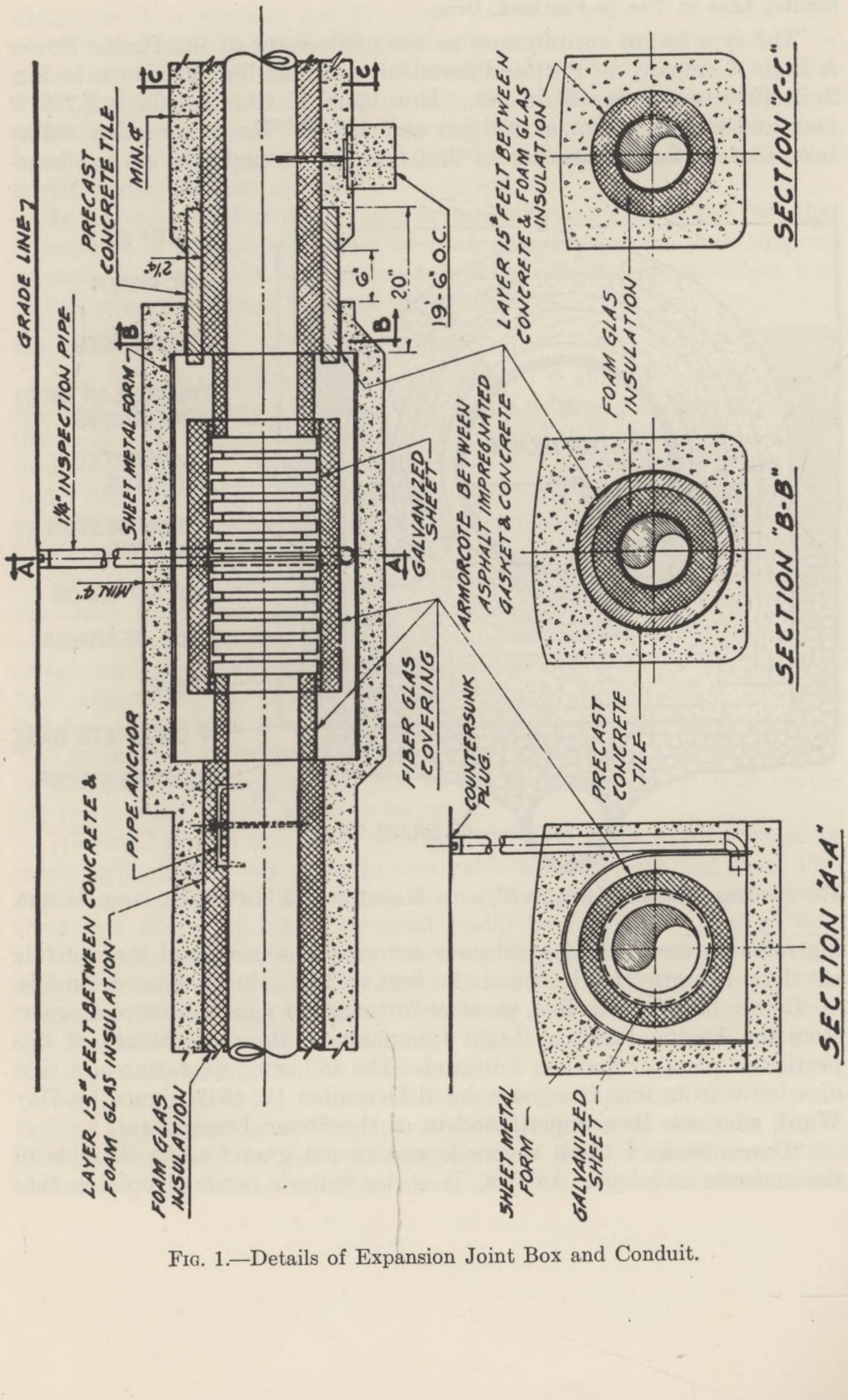



FIG. 1.—Details of Expansion Joint Box and Conduit.

**Similar Line in Use in Portland, Oreg.**

The type is not entirely new as the predecessor of the Pacific Power & Light Company in Portland installed a similar line, as shown in Fig. 2, in 1919, which is still in use. This 12 in. Portland main is 3,750 ft long and carries steam at 250 psi and 550 F. Its construction differs from that of the Duluth line in that the pipe is supported on ball bear-

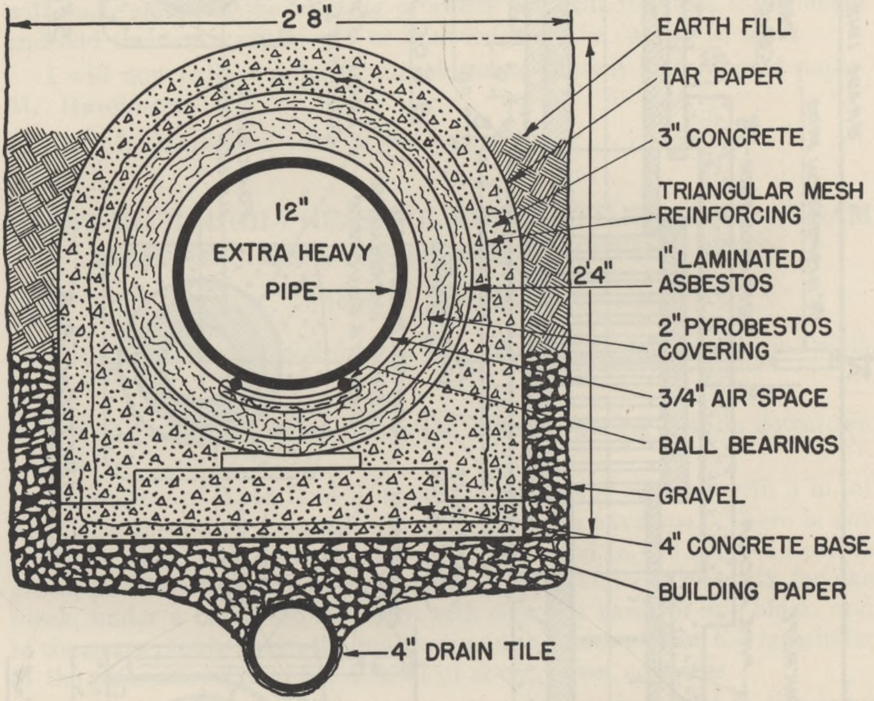



FIG. 2.—Cross Section of Similar Type of Main Installed in Portland, Oreg., in 1919.

ing rollers, asbestos and pyrobestos covering was used, and the concrete envelope has gravel fill around the bottom half, plus a 4 in. drain tile.

Before building our line, we were fortunate to receive a current report from the Pacific Power & Light Company on the performance of this particular piece of main in Portland. The following quotation is a part of a letter from that Company dated December 12, 1948, signed by Day Ward, who was then Superintendent of the Steam Department.

"One mistake I think we made was to put gravel along the side of the concrete envelope. In fact, it is the writer's personal opinion that drain tile is a mistake for this type of construction. A water leak occurring close to the line will eventually reach the gravel and flow for some distance along the concrete envelope. If the drain tile happens to be plugged, which it eventually does, trouble becomes general instead of remaining localized." He further states that, "From all observations, I believe the concrete envelope still to be watertight and that the line is still giving efficient service."

It was more or less due to this favorable report and to the fact that it required a minimum number of manholes, eliminated pipe supports as such, and any need for wooden forms for the concrete envelope, that this Company installed a line of this type.

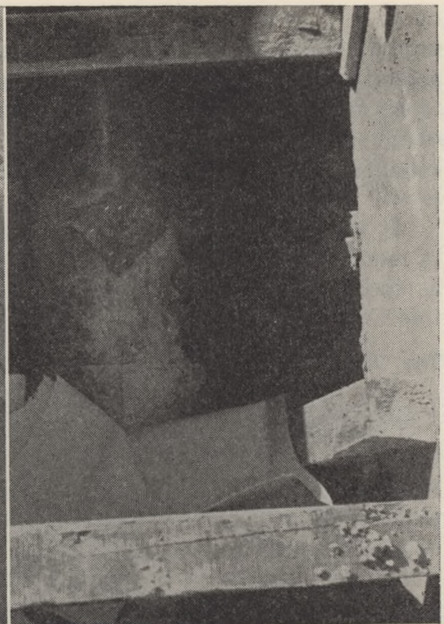
**The Duluth Line**

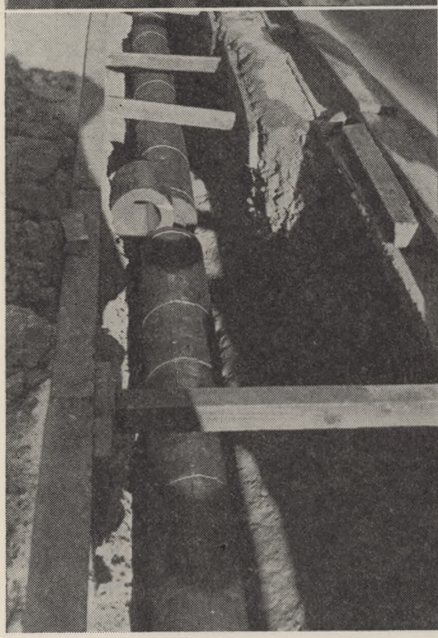
The biggest problem was the selection of a suitable insulation. It was necessary to have a covering that would be strong enough to support the weight of the pipe under all conditions and still provide the required insulating efficiency. After experimenting with several types of covering under flood conditions, Foamglas, although more expensive, was selected because its compressive strength did not change when wet and because it is chemically inert, is waterproof, and possesses a low "K" factor.

The trench for this line was dug so that the walls and bottom formed the outer boundaries for the concrete envelope. After it was dug to rough grade, the finished grade of the line was established by the use of metal saddles set on concrete blocks as shown in Fig. 3. To facilitate final alignment, the saddles were not fastened to the block but were left free to move on it until the pipe was in place and welded together. The grade thus properly established, it was possible to rotate as many as five forty-foot sections of pipe at one time, thereby greatly reducing the number of *still* welds to be made.

Although it was not done, it is believed that these saddles could be made up in such a way as to be removable from beneath the pipe. This could be accomplished by making them in two pieces held together with some sort of pin or bolt that could easily be removed. If they were to be removed, it would first be necessary to pour the concrete envelope around several sections of the line between the saddles to provide the necessary line support. This is mentioned because it is thought that this would be an improvement in the design, as all corrosive metal to metal contacts then would be eliminated and the saddles could be reused.

Sections of covering were placed around the pipe and held in position by stapling strips of tar paper across the joints, as shown in Fig. 4. One layer of 15 lb tar felt roofing paper was then wrapped around the covering. This was stapled in place. Of the several methods tried,





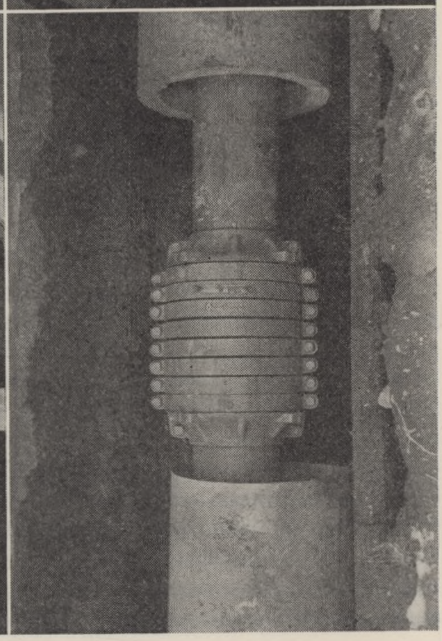


FIG. 3.—Section of 8-In. Pipe Showing Supporting Concrete Blocks.

FIG. 5.—Section of 8-In. Line Showing Binding Wires and Stapled Tar Felt Wrap.

FIG. 4.—Sections of Foamglas Covering Showing Tar Paper Strip Stapled in Place.

FIG. 6.—Expansion Joint Showing Galvanized Tube and Precast Concrete Tile.

stapling was found to be by far the quickest and best method for securing the tar paper wrap in place until the concrete envelope was poured and set. An ordinary 5/16 in. stapling machine was used. The welded joints were not covered until after the line was tested with steam. The tar felt was further secured by placing a binding wire at the ends of each wrap as shown in Fig. 5 to prevent wet concrete from seeping in between the tar felt and the Foamglas.

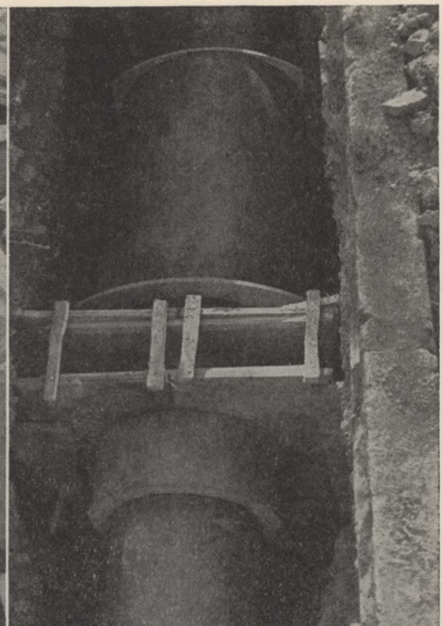
The primary purpose of the wrap of tar felt roofing paper is to form a parting between the concrete envelope and the covering so they are free to expand and contract individually. This is desirable because of the different coefficients of expansion of the concrete and the Foamglas.

After each section of the line was tested, the welded joints were covered and a 4 in. concrete envelope was poured around the covering. The top of this envelope was rounded off so that it would shed water. The mix used for this envelope included six sacks of cement per cubic yard of concrete. This additional cement increased the density and improved the waterproofing characteristics of the envelope.

Fig. 1 shows cross sections of the construction at the expansion joints. Expansion of the concrete envelope, as well as of the pipe, is provided for at these locations. The concrete base was first poured to act as a floor. Before the expansion joint was welded in place, a precast concrete tile and a galvanized sheet metal tube, shown in Fig. 6, were slipped on the pipe.

The expansion joint was welded into the line and then the galvanized tube was slid into position so that it covered the expansion element. A covering of double thick Fiberglas insulation was then placed around the galvanized metal tube and wired in place. A preformed ⅛ in. sheet metal arch was next placed over the covering and wooden forms set in position at the ends of the arch as shown in Fig. 7 to keep the concrete out of the space housed by the arch.

The 1¼ in. listening tube was provided to aid in checking the joints for steam leaks. An anchor is shown in the foreground. The precast concrete tile was then slid along the line until one end extended about 3 in. into the space under the metal arch. This tile is 24 in. long and large enough in diameter so that its fits snuggly around the pipe insulation. Two wooden forms were next placed around the tile, one about 6 in. and one about 12 in. from the metal arch, thus forming a 6 in. void. The purpose of this 6 in. void is to provide a space to take up any expansion of the concrete envelope itself. The tile acts as a gland being free to move in a horizontal direction through a watertight joint between the tile and the concrete envelope.



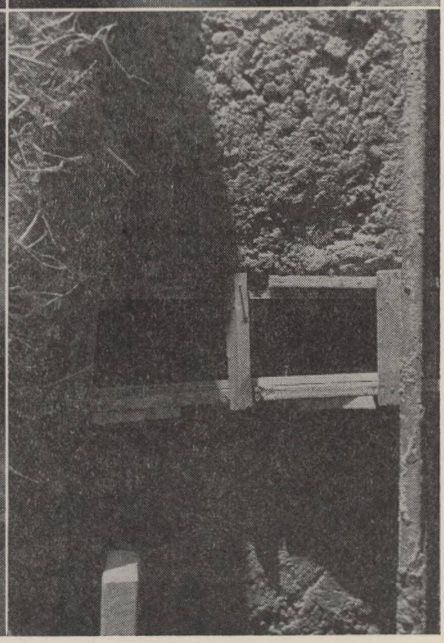


FIG. 7.—Section of Line at Expansion Joint Showing Anchor, Sheet Metal Arch, and Wooden End Forms.

FIG. 8.—Section of Line at Expansion Joint Showing Wooden Forms in Place.

FIG. 9.—Section of Line at Expansion Joint Showing Asphalt Impregnated Mastic Strip in Place.

FIG. 10.—Section of Line at Expansion Joint after Concrete Envelope was Poured.

This joint, shown in Fig. 9, is made up of a strip of asphalt impregnated mastic 6 in. wide and ½ in. thick, and is coated with Armorcote to assure a watertight joint. The concrete envelope was poured around the tile and metal arch as shown in Fig. 10. This type of construction eliminates the use of manholes for housing the expansion joints.

All of the actual work on this main was done by contractors with the exception of covering the pipe, which was done by our Service Department. One contractor was responsible for the breaking of the surface, trenching, grading, installing anchors and the manhole, pouring the concrete envelope, backfilling, and resurfacing. This work was done on a cost plus 15 per cent basis. The piping contractor had the job of hauling and placing the pipe in the trench, and aligning and welding it. This work was done on a flat bid.

Below is a cost analysis on a per foot basis for the 2,344 ft of 8 in high pressure steam main.

| Item | Cost | Cost per Ft. |
|---|---|---|
| 1. Breaking Surface, Trenching, Grading, Installing Anchors, Saddle Blocks, One Manhole, Backfilling and Resurfacing (Figures include 15 per cent contractor's profit.) | $24,128.25 | $10.29 |
| 2. Concrete Envelope—328 yd @ $14.37 (Figures include 15 per cent contractor's profit.) | 4,704.36 | 2.00 |
| 3. Stringing and Welding Pipe (There were 128 welds made.) | 5,731.28 | 2.44 |
| 4. Insulating Pipe—Labor (Figures include expansion joints, anchors and manholes.) | 443.74 | .19 |
| 5. Insulation Material (Figures include pipe insulation only—2205 ft of Foamglas and Fiberglas.) | 7,814.69 | 3.54 |
| 6. Pipe, Valves, Anchors, Saddles, and Miscellaneous Material | 7,813.70 | 3.33 |
| 7. Expansion Joints—Material Total of 16 joints used. (Figures include wood and metal forms, Fiberglas covering and precast concrete tile.) | 4,615.94 | 1.97 |
| Total | $55,251.96 | $23.76 |

Item No. 1 of the above cost analysis is approximately $5,000.00 high due to the following contingencies and abnormal conditions encountered during construction:

1. A heavy rain caused one block of the trench to wash out and cave in in numerous spots;
2. The rock encountered in two blocks;
3. The freezing of the backfill during the last four weeks of construction, making it necessary to use air hammers to break it up.

It will be necessary to spend approximately $1,000.00 more this spring on resurfacing and regrading over the line where the ground has settled and will settle.

Item No. 1 includes the cost of breaking and resurfacing approximately 1,800 sq ft of sidewalk and 1,180 sq ft of concrete base, black top street.

At the date of writing, this line has been in operation a little under three months. This is hardly a long enough period to draw any final conclusions on its performance. However, all observations seem to indicate that it is going to live up to expectations. The path of the line has been covered with snow since December 1st, indicating adequate insulation. No evidence of water has been observed anywhere.

*Robert B. Donworth:* What are the general labor rates in that section of the country? In other words, suppose we had identical conditions in the East somewhere, except for labor scale; how much more would the line cost?

*John C. Haroldson:* Common labor in Duluth averages $1.50 per hour and the various foremen average $2.00 per hour. The welding was done on a flat bid basis. There were 128 welds in all to be made, 24 position welds, 82 rolling welds, 16 anchor welds, and 6 blank end welds for testing purposes.

*Robert B. Donworth:* What is a welder's pay rate?

*John C. Haroldson:* It is $2.50 an hour.

*Charles W. Deeg:* How deep is that line?

*John C. Haroldson:* This line has an average depth of four feet to the bottom of the trench.

*Charles W. Deeg:* Did you have to haul the excavated material away or are you permitted to pile it alongside the trench?

*John C. Haroldson:* Approximately one-half of it was hauled away. When it is necessary to excavate in the streets or sidewalks, the earth has to be hauled away and the trench backfilled with sand and gravel. However, the piling of earth alongside the trench is permitted.

*Charles W. Deeg:* Did you say you did not do any shoring?

*John C. Haroldson:* A modest amount of shoring was necessary. However, I want to point out again that the cost figure of Item 1 includes the contractor's profit of 15 per cent.

*Albert F. Metzger:* That was a time and material plus percentage job. Would you say that the contractor's relationship with the company was a little better on that job and that you got more cooperation and more speed than on other jobs?

*John C. Haroldson:* No, I would say that the over all cost of work would have been lower if the welding contractor's work had been better coordinated with the excavating contractor's work. There is no doubt but what the work would have progressed more rapidly and at less cost if the welding contractor's crew had been sufficient to complete the pipe work as quickly as the trench was graded and ready for pipe. The total cost of the job probably suffered some from the fact that the ditching was done on a cost plus basis, while the pipe laying and welding was done on a flat price contract for the job. The excavating contractor's original estimate on Item 1 was about half of the actual cost. Some of the increased cost was due to the abnormal conditions encountered, but when we first figured costs and secured the contractor's estimate, it looked like the line would be built for $16.00 a foot. I still believe that this type of line could be put in at a cost of $2.00 per foot per inch of pipe diameter.

*Chairman Saurwein:* Thank you, Mr. Haroldson and gentlemen.

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In the absence of Robert F. Throne of the Public Service Company of Colorado, John L. McKinley of the same company will present his prepared paper on construction in Denver. Mr. McKinley.

. . . Mr. McKinley then presented the prepared paper . . .

## HEATING-SYSTEM EXPANSION AT DENVER AND USE OF PRECAST-CONCRETE MANHOLES

**Robert F. Throne**

(In this paper the author reports upon the merits of precast manholes in connection with installation of a 7832-foot steam-transmission line as a part of the load-expansion program of the Denver Steam Heating System with some references to the conditioning and metering of the turbine-bled steam at the plant and the overall cost of the project.)

The business district of Denver has been served district steam during the 9-month heating season since 1889 by the Public Service Company of Colorado and its predecessors. The distribution system has been periodically extended as the business area expanded and in 1910 was entirely rebuilt to its present service area.

The greatest sendouts of about 125,000 lb per hour were attained in 1920 and 1921, since which period the replacement of district steam continuously increased due to a combination of many factors, such as competitive fuels and the small capitalized value of basement area.

For a number of years, district-heating service was rendered at a loss